User Guide for
Land Surface Atmospheric Boundary Interaction Product (LANDMET)

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Summary:

Investigations of land-atmosphere interactions have usually tended to rely, in part, on a variety of models to describe either atmospheric conditions near the land surface (global or regional weather analyses or forecast models) or the variations of land surface properties forced by changing weather conditions (land surface models) because some aspects of the near-surface meteorology or land properties were not readily available from observations. In fact there is a rich variety of observations available from conventional surface-based and satellite sources, but these have generally been used in "piecemeal" comparisons to these models, not usually as an integrated set of information that encompasses the whole complex of land-atmosphere interactions. Earlier projects to pull together global, combined data products, namely the International Satellite Land Surface Climatology Project (ISLSCP I and II, Hall *et al.* 2006) and the Global Soil Wetness Project (GSWP, which used some of the ISLSCP product, Dirmeyer *et al.* 1999), were focused primarily on asseling a comprehensive set of the atmospheric "forcing" for land surface models (LSMs).

This new product is a multi-variate data compilation that reconciles the variation scales of these multiple measurements, merges and maps them into a comprehensive description of the near-surface atmospheric properties together with the land surface property variations on diurnal-to-decadal time scales. The land surface is represented by land fraction, land surface type, topography (mean and standard deviation), total effective and black sky spectral albedoes at solar wavelengths, thermal effective infrared and microwave emissivities, temporary flooding fraction, soil moisture, snow cover fraction and skin temperature. The atmosphere is represented by temperature and humidity profiles from the surface up to the 500 hPa level, surface windspeed, precipitation amount and type, low-level cloud types and amounts, net SW and LW radiative fluxes at the surface and at 680 hPa, and turbulent sensible and latent heat fluxes at the surface. Despite the increase of the number of available data products, their differences in space-time resolution preclude making a merged product at finer spatial intervals than about 100 km and finer time intervals than daily, but any product with finer time sampling is reported here at 3-hr intervals. The time period overlap among the products covers only 10 years, 1998-2007. In other words, available data still do not allow for much improvement over the first ISLSCP product in terms of space-time resolution and coverage. The LANDMET data product is comprised of a sequence of daily global files, where quantities are mapped into 1.0-degree-equivalent equal-area grid. The format is netCDF-4.

Many of these data products, especially those based on surface measurements, are spatially and/or temporally sparse or incomplete in coverage, so procedures were developed to fill missing values. These procedures are based on evaluations of the characteristic space-time scales of variability of each quantity. Because of the spatial heterogeneity of the land surface and larger-scale variations of the atmosphere, time interpolation at each location is the preferred filling method.

The LANDMET product is comprised of 4 Ancillary products that are fixed in time but vary with location, 3 Land Surface properties that vary at daily intervals and 7 Surface and Lower Atmospheric properties that vary at 3-hr intervals. The global maps are arranged in daily files with eight components for those quantities reported at 3-hr intervals.

1. Sources of Data and Their Characteristics

1.1 Ancillary Quantities

Land Surface Type: The land surface type information includes, for each map grid cell, the type and coverage fractions of the top three surface types present in the cell. The sum of these three fractions may not equal the land fraction if more types are present (usually a small difference). This information is taken from the ISCCP SURFACETYPE product (ISCCP C-ATBD), which is a merger of the IGBP-DISC surface type product (Loveland *et al.* 2009, obtained from the USGS EROS data center at http://daac.ornl.gov/ISLSCP_II/guides/edc_landcover_xdeg.html) and the GLIMS permanent glacier cover product (Armstrong *et al.* 2005, obtained from http://www.glims.org), both of which have been reconciled to the ISCCP TOPO land fraction (see below). The ISCCP SURFACETYPE product has an original equal-area mapping at 0.25 degrees-equivalent, but is here reduced to 1.0 degree equal-area.

Total Effective and Spectral Albedos: The Total Effective Surface Albedo at solar wavelengths is taken from the ISCCP FD radiative fluxes product (2.5 degree-equivalent equal-area, Zhang *et al.* 2004) and the Spectral Albedos are from the MODIS black-sky product (1 km interval, https://www.umb.edu/spectralmass/terra_aqua_modis/modis_brdf_albedo_cmg_gap_filled_snow_free_product_mcd43gf_v005, Moody *et al.* 2005) at seven wavelengths (0.47, 0.55, 0.67, 0.86, 1.24, 1.64 and 2.1 μm). The albedo estimates used in the ISCCP FD flux calculations were determined from the retrieval of visible reflectance and a surface-type-dependent spectral representation that was compared with the MODIS product; the largest differences occurred at wavelengths longer than about 0.8 microns but had little effect on the calculated net SW flux at the surface. The value reported as the Total Effective Albedo is determined from the ratio of the upwelling to downwelling SW fluxes in the ISCCP FD product, representing an average over all wavelengths and all-sky illumination conditions. The monthly mean and standard deviation were calculated for MODIS from the original 5 km resolution. The monthly mean FD values were extracted from the 2.5 degree equal-area product and saved at 1.0 degree equal-area.

Thermal Effective Infrared and Microwave Emissivities: The broadband thermal IR emissivity is taken from the ISCCP FD radiative fluxes product (2.5 degree equal-area, Zhang *et al.* 2004), the emissivity at 10.5 microns is from the ISCCP IREMISS product (0.25 degree equal-area, ISCCP C-ATBD) and the microwave emissivities at four frequencies and two polarizations is from the combined analysis of SSM/I and window IR based on ISCCP DX product (0.25 degree equal-area, Aires *et al.* 2001). The broadband thermal infrared emissivity is the ratio of the upwelling LW flux to the blackbody flux at the given surface skin temperature. The IREMISS values are produced by a reconciliation of three products from AIRS (V6 L2 , Chahine *et al.* 2006, http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs), MODIS (Wan 2014) and IIR (*e.g.*, Garnier *et al.* 2012).The monthly mean broadband thermal emissivity from FD was extracted from the 2.5 degree product and saved at 1.0 degree equal-area. The surface microwave emissivity was extracted at 0.25 degrees and the monthly mean and standard deviation saved at 1.0 degree equal-area. The ISCCP IREMISS was weighted by the percentage

of each type found in each equal cell of the ISCCP SURFACETYPE product, and the resulting emissivities were saved at 1.0 degree equal-area.

1.2. Daily Quantities

Constant quantities (reported for convenience):

Land Fraction: The fraction of land in each grid cell is taken from the ISCCP TOPO data product (ISCCP C-ATBD), which combines and reconciles the GTOPO30 product and the 1 KM AVHRR land mask product from the USGS EROS data center (respectively, http://lta.cr.usgs.gov/GTOPO30, http://edc2.usgs.gov/1KM/land_sea_mask.php). The permanent open water fraction is given by 1.0 minus the land fraction.

Topography: The mean and standard deviation of topographic height (in meters) is taken from the ISCCP TOPO product, which is a reconciliation of the GTOPO30 (original grid interval about 0.9 km, obtained from the USGS EROS data center at http://lta.cr.usgs.gov/GTOPO30) and the AVHRR 1KM Land Mask (obtained from the USGS EROS data center at http://edc2.usgs.gov/1KM/land_sea_mask.php). Comparison of these two products led to small adjustments of land fraction, favoring GTOPO30 at the coastlines, but retaining the AVHRR 1KM identification of larger inland lakes. These two products were also compared to the ETOPO product; differences were "noise-like" but concentrated at coastlines and in high topography regions. These quantities were mapped to a 0.1 degree-equivalent equal-area map (about 10 km intervals) and then reduced to 1.0 degree-equivalent equal-area. . These quantities are supplied daily for ease of use.

Variable quantities:

Temporary Flooding Fraction: The flooding fraction, interpreted as the additional coverage by open water beyond the permanent fractional coverage (1.0 – land fraction), is taken from the monthly Inundation product (noaacrest.org/rscg/Produts/LSH/extent.html, Papa *et al.* 2006, 2007, 2008a, 2008b, Prigent *et al.* 2007), which is mapped at 0.25 degree equal-area. This product was compared in specific regions to a much higher resolution satellite radar product. The all-record minimum inundation fraction was compared to the permanent open water fraction (1.0 – land fraction) and found to be in general agreement to within about 5%; slightly larger positive differences were concentrated in the Canadian lakes region. Therefore the Inundation product was converted to an anomaly fraction by subtracting the all-record minimum value at each location. These monthly anomalies were re-mapped to 1.0 degree equal-area and linearly interpolated between mid-month dates to produce values for each day.

Soil Moisture: The soil moisture (in m^3/m^3) information comes from the GEWEX fusion of satellite active and passive microwave measurements (http://www.esa-soilmoisture-cci.org; contact = cci_sm_contact@eodc.eu, Liu, *et al.* 2011, 2012, Wagner *et al.* 2012) at daily intervals in a 0.25 degree equal-angle map grid. The soil porosity and wetlands coverage from this product are also reported as Ancillary information. These quantities are re-mapped to a 1.0 degree equal-area grid.

Snow Cover Fraction: The daily snow cover fraction at 0.25 degree equal-area is from the

Microwave Snow product (noaacrest.org/rscg/Produts/LSH/snowcover.html, Shahroudi and Rossow 2014) for 1998 -2004 and the 0.25 degree resolution ISCCP SNOWICE product for 2005-2007. The first is derived from an analysis of the SSM/I-DX microwave emissivities. This product was evaluated against three other snow products, including the one produced from MODIS (Shahroudi and Rossow 2014). The second is based on the NOAA NSIDC IMS Daily Northern Hemisphere Snow and Ice Analysis at 24 km Resolution (Helfrich *et al.* 2012). The snow cover fractions are averaged into a 1.0 degree equal-area.

1.3. 3-Hourly Quantities

Skin Temperature: The skin temperature (in Kelvins) is taken from the ISCCP FD product (2.5 degree equal-area grid) (Zhang *et al.* 2004, 2007). This product was evaluated by comparisons to results from MODIS and AIRS. The skin temperatures are extracted from the original 2.5 degree equal-area grid and mapped into a 1.0 degree equal-area grid.

Atmospheric Temperature-Relative Humidity Profile: The atmospheric profiles of temperature (in Kelvins) and relative humidity (in percent) from the surface to the 500 hPa level are taken from the ISCCP NNHIRS product (1.0 degree equal-area grid, ISCCP C-ATBD) that is based on a new analysis of HIRS IR sounder measurements (Shi *et al.* 2016). This product was evaluated against the ARSA collection of radiosondes (Analyzed RadioSounding Archive (ARSA) database, http://ara.abct.lmd.polytechnique.fr/index.php?page=arsa) and surface weather station reports (ISD, see next).

Surface Windspeed: The surface windspeeds (in m/s) are from the ISD collection of surface weather station reports (www.ncdc.noaa.gov/isd, Smith *et al.* 2011). These estimates are reported on a 1.0 degree-equivalent equal-area grid; the number of stations averaged is also given. The values of near-surface air temperature and relative humidity from the surface measurements are also reported.

Precipitation Rate, Type and Fraction: The precipitation rate (in mm/hr) is a merger of the TMPA product (mapped at 0.25 degrees) for latitudes equatorward of 50 degrees (Huffman *et al.* 2007) and the GPCP product (mapped at 1.0 degrees) for the polar regions (http://precip.gsfc.nasa.gov/ -- for info: http://precip.gsfc.nasa.gov/gpcp_daily_comb.html, Huffman *et al.* 2001). The daily GPCP values are divided equally among eight times of day, converting mm/day to mm/hr (*cf*. Rossow *et al.* 2013). These two products were compared to each other for consistency; the GPCP product over land merges satellite and surface-based measurements. Precipitation type is determined by the corresponding near-surface air temperature (TA) from the ISCCP NNHIRS product: flag = 0 is liquid precipitation and flag = 1 is frozen precipitation when TA < 268 K. Any location flagged as undefined in the TMPA product is filled with values from GPCP; an Origin Code is included (0 for TMPA, 1 for GPCP). The precipitation fraction, defined as the ratio of the average precipitation including and excluding zero values, is reported to indicate area extent of precipitation. These quantities were re-mapped from a 1.0 degree equal-angle grid to a 1.0 degree equal-area grid.

Low-level Cloud Properties: The low-level cloud types and cover fractions, along with the total and deep convective cloud fraction, are reported together with the lowermost cloud base pressure, uppermost cloud top pressure and total cloud fraction. These quantities are taken from the ISCCP FD radiative flux product (mapped on a 2.5 degree equal-area grid), which is a combination of the ISCCP D-Version cloud products (Rossow and Schiffer 1999) and a statistical model used to estimate the cloud properties for layers not seen directly from the

satellite (Zhang *et al.* 2004). The statistical model has been evaluated by comparison to the merged CloudSat-Calipso cloud vertical profiles (Rossow and Zhang 2010). A low-level cloud is reported if uppermost cloud top pressure for the lowest cloud layer present is greater than 500 hPa, but deep convective cloud fraction is included regardless of top pressure. The presence of other cloud layers is indicated by a difference between total and low-cloud amounts. These quantities are re-mapped to 1.0 degree equal-area.

Net SW and LW Radiative Fluxes: The net SW and LW fluxes (in W/m^2) at the surface and at the 680 hPa level are taken from the ISCCP FD radiative fluxes product (2.5 degree equal-area grid, Zhang *et al.* 2004). The sign of the net fluxes indicates energy **into** the atmospheric layer from 680 hPa to the surface. For example, the net SW (LW) flux at 680 hPa is positive (negative) and negative (positive) at the ground. The surface radiative fluxes have been evaluated against other similar products from GEWEX SRB and CERES and against the BSRN reference network. The near-surface air temperature used to calculate downwelling LW fluxes is also reported. These quantities are re-mapped to 1.0 degree equal-area.

Sensible and Latent Heat Fluxes: These fluxes (in W/m^2) come from the Princeton product that is a prototype of the GEWEX LANDFLUX products. The input data is mapped at 0.5 degree square-grid and is obtained from http://hydrology.princeton.edu/data/landflux/, Vinukollu *et al.* 20011). Quantities included are contributions to total evapotranspiration from plant transpiration, wet canopy, soil, snow and open water. These quantities are re-mapped to 1.0 degree equal-area.

2. Reconciliations

The land fraction, land surface type and topography datasets from different sources are reconciled in terms of their land fractions, taking the much higher resolution topography and AVHRR 1KM land masks as the references. The latter two products are adjusted so as to preserve the identification of large inland lakes in the AVHRR IKM product – the topography dataset reports heights for these locations, which are retained, without discriminating the surface type (ISCCP C-ATBD). This version of these datasets reports consistent land fractions at 0.25 degree equal-area, which are then averaged to 1.0 degree equal-area.

The ISCCP FD radiative flux product assumes that the spectral dependence of surface albedo is determined by surface types but consistent with the ISCCP Cloud Product visible reflectances for each location (Zhang *et al.* 2004). The spectral shape of the surface albedo as a function of surface type was compared with the MODIS spectral albedo product (black sky). The FD spectral shapes were biased relative to the MODIS product, but entirely in the near-IR at wavelengths longer than about 0.8 microns. Using the MODIS products in the calculations did not change the net SW fluxes by more than a few percent. Hence the MODIS product reported here is consistent with the FD net SW surface fluxes. The total surface albedo reported here is the ratio of upwelling to downwelling SW fluxes from the ISCCP FD product, equivalent to an illumination spectrum-weighted value for all sky conditions (clear and cloudy sky) and the MODIS spectral albedos are the black sky version.

The thermal infrared emissivity at 10.5 μm wavelength from IREMISS is based on the reconciliation of three products sorted by surface type, from the MODIS LST product, the AIRS LST product and another LST product from the IIR instrument on the Calipso satellite. These

products are compared for overlapping years, showing little time-variability. Generally the results agree to better than one percent; the few cases of disagreement are resolved in favor of the MODIS results.

The 16-yr minimum flooding fraction from the monthly inundation product at each location was compared to permanent water fraction (1.0 – land fraction) in the reconciled surface type dataset. In general the minimum fraction agreed to within 5% fractional area at 0.25 degree equal-area; the few regions with somewhat larger disagreements were concentrated in the central Canadian lake region. Therefore, the reconciliation of these two water fraction datasets was done by converting the inundation values into time-record-anomalies by subtracting the record-minimum at each location. This anomaly value is then linearly interpolated from monthly (assigned to the mid-month day) to daily values and interpreted as the additional water fraction over and above the permanent water fraction.

The Soil Moisture is compared to the temporary flooding and precipitation products for consistency. The near-surface air temperature from ISCCP NNHIRS is used to remove values reported for locations that are too cold to have liquid water present near the surface; soil moisture values for any locations that are labeled as permanent glacier in the surface type product are also removed.

As part of the snow cover fraction retrieval from combined microwave and infrared satellite measurements, the presence of snow is required to be consistent with surface skin temperatures below 273 K.

Over land the ISCCP NNHIRS temperature and humidity profiles were compared to ARSA radiosondes, showing that there were no significant biases in temperature or humidity. However, the comparison of near-surface air temperatures and humidities to the ISD surface weather station reports showed a small (of order a few degrees) temperature-dependent bias in temperatures. The near-surface air temperatures were corrected to reduce these biases. Although the comparison suggests that the NNHIRS near-surface humidities are slightly smaller than the ISD values, the magnitude of this bias is generally within the uncertainties, so no change was made. The ISD values of near-surface temperature and relative humidity are also reported for comparison.

The two precipitation products, TMPA (3-hourly) and GPCP (daily), are produced from similar satellite inputs and merged with surface gauge data over land. The former product uses a more modern microwave retrieval and measurements from all available microwave instruments to obtain 3-hr sampling, whereas the latter uses data from only one microwave instrument at a time to obtain daily sampling. The former does not report values poleward of 50° but the latter uses satellite infrared measurements to fill in at higher latitudes. The agreement of the daily precipitation values from these two datasets is generally good, so we use TMPA as the main dataset but its coverage is completed using GPCP. The GPCP daily precipitation in mm/day is converted to mm/hr by dividing the daily amount equally among eight times per day (*cf*. Rossow *et al.* 2013).

3. Space-Time Variability & Filling Procedures

The daily soil moisture maps have many gaps. The first step to fill these is to linearly interpolate in time over a time interval up to ± 15 days at each location that is missing values. If only one valid value is available, then that value is replicated. If both available values (previous and subsequent) are labeled as "too cold", the missing value is also labeled as too cold. If the

time interpolation fails, the missing values are filled from a 12-monthly climatology produced solely from the original data but filled by linear interpolation over longitude at each latitude. Even after these two steps, there are regions in the tropics that are still missing – presumably due to the interference of persistent cloud cover and precipitation with satellite microwave measurements; thus, the soil moisture at these locations is filled with the record-maximum value (0.66 m^3/m^3).

Because of cloud effects on the measurements and the usual situation of measurements obtained from two instruments on satellites in sun-sychronous orbits, infrared temperature-humidity sounding products generally provide about 10-30% coverage of the globe at four times of day. To achieve the goal of adequate diurnal resolution and to compensate for the inhomogeneous time-of-day sampling over the whole time record, the NNHIRS product uses a statistical model of the diurnal variations of temperature, based on an 8-yr period (02/2001-01/2009) with three-to-four satellite coverage (six to eight samples per day). The statistical model was developed by, first, fitting the monthly mean diurnal anomalies (deviations from the average over all times of day for each satellite separately) at local hour intervals at each pressure level with a cubic spline. Then PCA is performed on the hourly anomalies from the daily mean temperature for each grid cell at each pressure level over the whole period 02/2001-01/2009. The final diurnal variation model uses only the first three PCs to smooth out the variations, which explains about 94% over land (*cf*. Aires *et al*. 2004). The rms differences between the 3-term and the all-term PCA representations were found to increase as the diurnal amplitude decreases so the PCA model was restricted to locations where the diurnal range is ≥ 2 K: over all land areas at pressure levels ≥ 500 hPa. Daily mean T profiles are determined for all days that have at least one daytime and one nighttime sample; the PCA-based bias corrections are applied to correct for the specific time-of-day sample available. If a daily mean value is not available on a particular day, the daily mean is obtained by interpolating from nearby daily mean values in a ± 5-day interval. If the interpolation fails because data are not available, the monthly averaged daily mean value is used; if there is no monthly mean, then the climatology for the appropriate month is used. The PCA model of diurnal anomalies is then applied to the daily mean T profiles from the surface up to the 500 hPa level. Based on ISD, the diurnal variations of humidity are small, the NNHIRS values the daily minimum values. Missing daily values are filled by linear interpolation of daily minimum (mean) values over a ± 5-day interval. If this interpolation fails, the monthly mean daily minimum value is used; if the monthly mean value is missing, the climatology from 02/2001-01/2009 is used.

The surface windspeed data generally have good time resolution and coverage but are completely absent in some regions. To fill in missing data, the first step was to create maps at each time step at different spatial resolutions, 1.0, 2.5 and 5.0 degree-equivalent equal-area, where all available values are averaged. Some map grids at each resolution contain values from a single station. Some missing values in all maps are then filled by linear interpolation in time up to an interval of $\pm$ 2 days; if only one value is available, it is replicated. Some additional missing values in the 5.0 degree map are filled by linear interpolation over longitude at each latitude. The remaining missing values in the 1.0 degree map are then filled by values from the 2.5 degree map; if no values are available from the 2.5 degree map, the fill values are taken from the 5.0 degree map.

4. Converting equal-area map to equal-angle map

All of the quantities in this dataset are stored in a 1-degree-equilvalent equal-area map; This mapping maintains approximately equal-areas by varying the longitude interval at each latitude; the latitude intervals are constant at 1 degree. Appendix 7 provides a simple procedure that uses map grid information in the dataset to re-project the data into a 1-degree equal-angle form. Following the pseudo code are sample maps and histograms for variables found in the 2003 01 01 netcdf file. The pseudo code is also included here for your convenience
By applying the following pseudo code an equal-area grid image can be represented as an equal-angle grid.

Retrieve variables from the netcdf file (In this example the physical variable is ttrop):

```
sqlon_beg,
sqlon_end,
eqlat_index
eqcell
ttrop

do icell=1,eqcell
  ilon1 = sqlon_beg(icell)
  ilon2 = sqlon_end(icell)
  ilat = eqlat_index(icell)
    do i=ilon1,ilon2
     sqmap(i,ilat) = ttrop(icell)
    enddo
enddo
```

The variable *sqmap(360,180)* can now be displayed in equal angle format.

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6. Appendix – Known Errors

variables pmaxt and ptrop in file landmet_L3_<date>_v1: should be listed as units= hPa

7. Appendix – NC_DUMP

```
netcdf landmet_L3_20030101_v1 {
dimensions:
      edge = 2 ;
      label_len = 22 ;
      eqcell = 41252 ;
      eqzone = 180 ;
      lon = 360 ;
      lat = 180 ;
      levels_t = 7 ;
      levels_rh = 7 ;
      low_cloud_type = 12 ;
      times = 8 ;
variables:
      float eqlon(eqcell) ;
            eqlon:long_name = "Center longitude of equal-area cell" ;
            eqlon:units = "degrees_east" ;
            eqlon:valid_min = 0. ;
            eqlon:valid_max = 360. ;
      float eqlat(eqcell) ;
            eqlat:long_name = "Center latitude of equal-area cell" ;
            eqlat:units = "degrees_north" ;
            eqlat:valid_min = -90. ;
            eqlat:valid_max = 90. ;
      short eqlon_index(eqcell) ;
            eqlon_index:long_name = "Longitude index of equal-area cell" ;
            eqlon_index:units = "1" ;
            eqlon_index:valid_min = 1 ;
            eqlon_index:valid_max = 360 ;
      short eqlat_index(eqcell) ;
            eqlat_index:long_name = "Latitude index of equal-area cell" ;
            eqlat_index:units = "1" ;
            eqlat_index:valid_min = 1 ;
            eqlat_index:valid_max = 180 ;
      short eqcells_in_zone(eqzone) ;
            eqcells_in_zone:long_name = "Number of longitude cells in each
equal-area zone" ;
            eqcells_in_zone:units = "1" ;
            eqcells_in_zone:valid_min = 1 ;
            eqcells_in_zone:valid_max = 360 ;
      int eqarea(eqcell) ;
            eqarea:long_name = "Equal-area cell area" ;
            eqarea:units = "km2" ;
      float lon(lon) ;
            lon:long_name = "Longitude" ;
```

```
            lon:units = "degrees_east" ;
            lon:valid_min = 0. ;
            lon:valid_max = 360. ;
            lon:bounds = "lon_bounds" ;
            lon:description = "Center longitude of square grid cell" ;
      float lon_bounds(lon, edge) ;
            lon_bounds:long_name = "Begining and ending longitude for each
longitude zone" ;
            lon_bounds:units = "degrees_east" ;
      float lat(lat) ;
            lat:long_name = "Latitude" ;
            lat:units = "degrees_north" ;
            lat:valid_min = -90. ;
            lat:valid_max = 90. ;
            lat:bounds = "lat_bounds" ;
            lat:description = "Center latitude of square grid cell" ;
      float lat_bounds(lat, edge) ;
            lat_bounds:long_name = "Beginning and ending latitude for each
latitude zone" ;
            lat_bounds:units = "degrees_north" ;
      short sqlon_beg(eqcell) ;
            sqlon_beg:long_name = "Square grid beginning longitude index"
;
            sqlon_beg:units = "1" ;
      short sqlon_end(eqcell) ;
            sqlon_end:long_name = "Square grid ending longitude index" ;
            sqlon_end:units = "1" ;
      short utctime(times) ;
            utctime:long_name = "Time steps" ;
            utctime:units = "hour" ;
            utctime:valid_min = 0 ;
            utctime:valid_max = 21 ;
            utctime:descripton = "8 UTC/day every 3 hours since 00:00:00z
current  day" ;
      short land_fraction(eqcell) ;
            land_fraction:long_name = "Land area fraction" ;
            land_fraction:units = "1" ;
            land_fraction:valid_min = 1 ;
            land_fraction:valid_max = 0 ;
            land_fraction:scale = 0.01 ;
            land_fraction:_FillValue = -9999s ;
            land_fraction:description = "Fraction of land found in equal
area cell" ;
            land_fraction:reference =
"http://www.noacrest.org/rscg/Products/SCT/topo.html" ;
      short height(eqcell) ;
            height:long_name = "Mean topographical height" ;
            height:units = "m" ;
            height:valid_min = 5417 ;
            height:valid_max = -48 ;
            height:description = "Mean topographical height above sea
level taken from ISCCP" ;
```

height:reference = "http://www.noacrest.org/rscg/Products/SCT/topo.html" ;
short sigma_height(eqcell) ;
sigma_height:long_name = "Topographic height standard deviation" ;
sigma_height:units = "m" ;
sigma_height:valid_min = 1744 ;
sigma_height:valid_max = 0 ;
sigma_height:description = "Standard deviation of mean topographical height taken from ISCCP " ;
sigma_height:reference = "http://www.noacrest.org/rscg/Products/SCT/topo.html" ;
short floodfrac(eqcell) ;
floodfrac:long_name = "Temporary flood area fraction " ;
floodfrac:units = "1" ;
floodfrac:valid_min = 0 ;
floodfrac:valid_max = 1 ;
floodfrac:scale = 0.01 ;
floodfrac:_FillValue = -9999s ;
floodfrac:description = "The fraction of the equal area cell occupied by flooded land" ;
floodfrac:reference = "http://www.noacrest.org/rscg/Products/LSH/extent.html,Papa, F., C. Prigent, and W.B. Rossow (2008): Monitoring flood and discharge variations in the large Siberian rivers From a multi-satellite technique.Surv. Geophys, doi:10.1007/s10712-008-9036-0,Papa, F., C. Prigent, F. Durand, and W.B. Rossow (2006), Wetland dynamics using a suite of satellite observations: A case study of application and evaluation for the Indian Subcontinent,Geophys. Res. Lett.,33, L08401, doi:10.1029/2006GL025767" ;
short vsm(eqcell) ;
vsm:long_name = "Volumetric soil moisture where persistently frozen values are removed." ;
vsm:units = "m3 m-3" ;
vsm:scale_factor = 0.001f ;
vsm:valid_min = 0.f ;
vsm:valid_max = 1.f ;
vsm:_FillValue = -9999s ;
vsm:description = "Soil moisture of the equal area cell, where persistently frozen data , as determined by NNHIRS near air surface temperature below 268K for the the day,is eliminated " ;
vsm:references = "http://www.esa-soilmoisture-cci.org; Liu, Y.Y., Dorigo, W.A., Parinussa, R.M., de Jeu, R.A.M. , Wagner, W., McCabe, M.F., Evans, J.P., van Dijk, A.I.J.M. (2012). Trend-preserving blending of passive and active microwave soil moisture retrievals, Remote Sensing of Environment, 123, 280-297, doi: 10.1016/j.rse.2012.03.appendix014; Liu, Y.Y., Parinussa, R.M., Dorigo, W.A., De Jeu, R.A.M., Wagner, W., van Dijk, A.I.J.M., McCabe, M.F., & Evans, J.P. (2011): Developing an improved soil moisture dataset by blending passive and active microwave satellite based retrievals. Hydrology and Earth System Sciences, 15, 425-436; Wagner, W., W. Dorigo, R. de Jeu, D. Fernandez, J. Benveniste, E. Haas, M. Ertl (2012): Fusion of active and passive microwave observations to create an Essential Climate Variable data record on soil moisture. ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences,

```
Volume I-7, 2012. XXII ISPRS Congress, 25 August ,Äì 01 September 2012,
Melbourne, Australia" ;
      ubyte vsmoflag(eqcell) ;
            vsmoflag:long_name = "Soil moisture origin flag" ;
            vsmoflag:flag_values = 0UB, 1UB, 2UB, 3UB, 4UB, 5UB, 6UB, 7UB,
255UB ;
            vsmoflag:flag_meaning = "original_data
snow_coverage_or_temperature_below_zero interpolated_data replicated_data
filled_with_maximum filled_with_climatology permanent_snow/glacier
undefined" ;
      short snowfrac(eqcell) ;
            snowfrac:long_name = "Fraction of equal-area grid covered with
snow" ;
            snowfrac:units = "1" ;
            snowfrac:scale_factor = 0.01f ;
            snowfrac:valid_min = 0 ;
            snowfrac:valid_max = 1 ;
            snowfrac:_FillValue = -9999s ;
            snowfrac:description = "Snow fraction determined from
microwave daily snow cover product (1998-2004) and the ISCCP daily snowice
product (2005 - 2007)" ;
            snowfrac:references =
"http://www.noacrest.org/LSH/snowcover.html;
http://www.noacrest.org/GGEWC/snowice.html" ;
      short FDtemps(times, eqcell) ;
            FDtemps:long_name = "Land surface skin temperature" ;
            FDtemps:units = "K" ;
            FDtemps:scale_factor = 0.1f ;
            FDtemps:valid_min = 165 ;
            FDtemps:valid_max = 355 ;
            FDtemps:_FillValue = -9999s ;
            FDtemps:description = " Surface skin temeprature is taken from
the ISCCP FD product" ;
            FDtemps:reference =
"http://www.ISCCP.giss.nasa.gov/projects/flux.html, Zhang, Y-C., W.B.
Rossow, A.A. Lacis, M.I. Mishchenko and V. Oinas,Calculation of radiative
fluxes from the surface to top-of-atmosphere\nbased on ISCCP and other
global datasets: Refinements of the radiative\ntransfer model and the
input data. J. Geophys. Res., 109, doi\n10.1029/2003JD004457 (1-27 + 1-
25), 2004." ;
      short presst(levels_t) ;
            presst:long_name = "Temperature pressure levels" ;
            presst:units = "hPa" ;
            presst:scale_factor = 0.1f ;
            presst:valid_min = 500. ;
            presst:valid_max = 1019 ;
            presst:description = "Pressure levels associated with
atmospheric temperature profile from the ISCCP NNHIRS product" ;
            presst:reference =
"http://www.noacrest.org/rscg/Products/GGEWC/NNHIRS.html" ;
      short pressrh(levels_t) ;
            pressrh:long_name = "Relative humidity pressure levels" ;
```

```
            pressrh:units = "hPa" ;
            pressrh:scale_factor = 0.1f ;
            pressrh:valid_min = 500. ;
            pressrh:valid_max = 1019 ;
            pressrh:description = "Pressure levels associated with
atmospheric relative humidity profile from the ISCCP NNHIRS product" ;
            pressrh:reference =
"http://www.noacrest.org/rscg/Products/GGEWC/NNHIRS.html" ;
      ubyte NNoflag(times, eqcell) ;
            NNoflag:long_name = "Origin code for NNHIRS" ;
            NNoflag:flag_values = 0UB, 1UB, 2UB, 3UB, 4UB, 5UB, 6UB, 7UB,
8UB, 255UB ;
            NNoflag:flag_meaning = "original daily-mean-pca 5d-daily-mean-
pca 30d-daily-mean-pca 8yr-daily-mean-pca daily-mean-nopca 5d-daily-mean-
nopca 30d-daily-mean-nopca 8yr-daily-mean-nopca  no-data" ;
            NNoflag:reference =
"http://www.noacrest.org/rscg/Products/GGEWC/NNHIRS.html" ;
      short NNta(times, eqcell) ;
            NNta:long_name = "Near-surface air temperature (2 meters)" ;
            NNta:units = "Kelvin" ;
            NNta:scale_factor = 0.1f ;
            NNta:valid_min = 160 ;
            NNta:valid_max = 350 ;
            NNta:_FillValue = -9999s ;
            NNta:description = "Near surface air temperature from the
ISCCP NNHIRS product" ;
            NNta:reference =
"http://www.noacrest.org/rscg/Products/GGEWC/NNHIRS.html" ;
      short NNtprofile(times, eqcell, levels_t) ;
            NNtprofile:long_name = "Atmospheric temperature profile to 500
hPa" ;
            NNtprofile:units = "Kelvin" ;
            NNtprofile:scale_factor = 0.1f ;
            NNtprofile:valid_min = 160 ;
            NNtprofile:valid_max = 350 ;
            NNtprofile:_FillValue = -9999s ;
            NNtprofile:description = "Atmospheric temperature profile up
to 500hPa from the ISCCP NNHIRS product" ;
            NNtprofile:reference =
"http://www.noacrest.org/rscg/Products/GGEWC/NNHIRS.html" ;
      short tmax(times, eqcell) ;
            tmax:long_name = "Maximum temperature" ;
            tmax:units = "Kelvin" ;
            tmax:valid_min = 160 ;
            tmax:valid_max = 350 ;
            tmax:_FillValue = -9999s ;
            tmax:scale_factor = 0.1f ;
            tmax:descripton = "Maximum profile temperature from the ISCCP
NNHIRS product" ;
            tmax:reference =
"http://www.noacrest.org/rscg/Products/GGEWC/NNHIRS.html" ;
      short ttrop(times, eqcell) ;
            ttrop:long_name = "Tropopause temperature" ;
            ttrop:units = "Kelvin" ;
```

```
            ttrop:valid_min = 160 ;
            ttrop:valid_max = 350 ;
            ttrop:_FillValue = -9999s ;
            ttrop:scale_factor = 0.1f ;
            ttrop:descripton = "Tropopause temperature from the ISCCP
NNHIRS product" ;
            ttrop:reference =
"http://www.noacrest.org/rscg/Products/GGEWC/NNHIRS.html" ;
      short psurf(times, eqcell) ;
            psurf:long_name = "Surface pressure" ;
            psurf:units = "hPa" ;
            psurf:valid_min = 10 ;
            psurf:valid_max = 1019 ;
            psurf:_FillValue = -9999s ;
            psurf:scale_factor = 0.1f ;
            psurf:descripton = "Surface pressure from the ISCCP NNHIRS
product" ;
            psurf:reference =
"http://www.noacrest.org/rscg/Products/GGEWC/NNHIRS.html" ;
      short pmaxt(times, eqcell) ;
            pmaxt:long_name = "Pressure at max temperature" ;
            pmaxt:units = "percent" ;
            pmaxt:valid_min = 10 ;
            pmaxt:valid_max = 1019 ;
            pmaxt:_FillValue = -9999s ;
            pmaxt:scale_factor = 0.1f ;
            pmaxt:descripton = "Pressure at maximum profile temperature
from the ISCCP NNHIRS product" ;
            pmaxt:reference =
"http://www.noacrest.org/rscg/Products/GGEWC/NNHIRS.html" ;
      short ptrop(times, eqcell) ;
            ptrop:long_name = "Pressure at tropopause" ;
            ptrop:units = "percent" ;
            ptrop:valid_min = 10 ;
            ptrop:valid_max = 1019 ;
            ptrop:_FillValue = -9999s ;
            ptrop:scale_factor = 0.1f ;
            ptrop:descripton = "Pressure at tropopause from the ISCCP
NNHIRS product" ;
            ptrop:reference =
"http://www.noacrest.org/rscg/Products/GGEWC/NNHIRS.html" ;
      short NNrha(times, eqcell) ;
            NNrha:long_name = "Near-surface relative humidity" ;
            NNrha:units = "percent" ;
            NNrha:valid_min = 0.5 ;
            NNrha:valid_max = 150. ;
            NNrha:_FillValue = -9999s ;
            NNrha:scale_factor = 0.01f ;
            NNrha:descripton = "Near-surface relative humidity from the
ISCCP NNHIRS product" ;
            NNrha:reference =
"http://www.noacrest.org/rscg/Products/GGEWC/NNHIRS.html" ;
```

```
      short NNrhprof(times, eqcell, levels_t) ;
            NNrhprof:long_name = "Relative humidity profile up to 500 hPa"
;
            NNrhprof:units = "percent" ;
            NNrhprof:valid_min = 0.5 ;
            NNrhprof:valid_max = 150. ;
            NNrhprof:_FillValue = -9999s ;
            NNrhprof:scale_factor = 0.01f ;
            NNrhprof:descripton = " Relative humidity profile up to 500
hPa from the ISCCP NNHIRS product" ;
            NNrhprof:reference =
"http://www.noacrest.org/rscg/Products/GGEWC/NNHIRS.html" ;
      short NNrhmaxt(times, eqcell) ;
            NNrhmaxt:long_name = "Relative humidity at max temperature" ;
            NNrhmaxt:units = "percent" ;
            NNrhmaxt:valid_min = 0.5 ;
            NNrhmaxt:valid_max = 150. ;
            NNrhmaxt:_FillValue = -9999s ;
            NNrhmaxt:scale_factor = 0.01f ;
            NNrhmaxt:descripton = "Relative humidity at max temperature
from the ISCCP NNHIRS product" ;
            NNrhmaxt:reference =
"http://www.noacrest.org/rscg/Products/GGEWC/NNHIRS.html" ;
      short NNrhtrop(times, eqcell) ;
            NNrhtrop:long_name = "Relative humidity at tropopause" ;
            NNrhtrop:units = "percent" ;
            NNrhtrop:valid_min = 0.5 ;
            NNrhtrop:valid_max = 150. ;
            NNrhtrop:_FillValue = -9999s ;
            NNrhtrop:scale_factor = 0.01f ;
            NNrhtrop:descripton = "Relative humidity at tropopause from
the ISCCP NNHIRS product" ;
            NNrhtrop:reference =
"http://www.noacrest.org/rscg/Products/GGEWC/NNHIRS.html" ;
      short ISDwspeed(times, eqcell) ;
            ISDwspeed:long_name = "Station wind speed" ;
            ISDwspeed:units = "m s-1" ;
            ISDwspeed:_FillValue = -9999s ;
            ISDwspeed:scale_factor = 0.1f ;
            ISDwspeed:description = "Surface wind speed retrieved from the
Integrated Surface Database" ;
            ISDwspeed:reference = "https://www.ncdc.noaa.gov/isd,
Smith,A., N. Lott and R.Vose, 2011: The Integrated Surface Database:
Recent developments and partnerships. Bull. Amer. Meteor. Soc., 92, 704-
708, doi:10.1175/2011BAMS3015.1." ;
      ubyte ISDwflag(times, eqcell) ;
            ISDwflag:long_name = "Station wind orgin code" ;
            ISDwflag:flag_values = 1UB, 2UB, 3UB, 4UB, 5UB, 6UB, 255UB ;
            ISDwflag:glag_meaning = "original_value interpolated_value
replicated_value filled_with_2.5_degree filled_with_5.0_degree undefined
undefined" ;
      short ISDwcount(times, eqcell) ;
            ISDwcount:long_name = "Number of stations used to calculate
the wind speed" ;
```

```
            ISDwcount:units = "1" ;
            ISDwcount:_FillValue = -9999s ;
            ISDwcount:description = "Number of stations used to calculate
the wind speed average for each equal-area grid cell" ;
      short ISDta(times, eqcell) ;
            ISDta:long_name = "Near-surface air temperature from the ISD
collection" ;
            ISDta:units = "Kelvin" ;
            ISDta:scale_factor = 0.1f ;
            ISDta:valid_min = 160 ;
            ISDta:valid_max = 350 ;
            ISDta:_FillValue = -9999s ;
            ISDta:description = "Near-surface air temperature retrieved
from the Integrated Surface Database" ;
            ISDta:reference = "https://www.ncdc.noaa.gov/isd,Smith,A., N.
Lott and R.Vose, 2011: The Integrated Surface Database: Recent
developments and partnerships. Bull. Amer. Meteor. Soc., 92, 704-708,
doi:10.1175/2011BAMS3015.1. " ;
      ubyte ISDtaflag(times, eqcell) ;
            ISDtaflag:long_name = "Near-surface air temperature orgin
code" ;
            ISDtaflag:flag_values = 0UB, 1UB, 2UB, 3UB, 4UB, 5UB, 255UB ;
            ISDtaflag:flag_meaning = "original_value interpolated_value
replicated_value filled_with_2.5_degree filled_with_5.0_degree undefined "
;
      short ISDtacount(times, eqcell) ;
            ISDtacount:long_name = "Number of stations used to calculate
the air temperature average" ;
            ISDtacount:units = "1" ;
            ISDtacount:_FillValue = -9999s ;
            ISDtacount:description = "Number of stations used to calculate
the air temperature average for each equal-area grid cell" ;
      short ISDrha(times, eqcell) ;
            ISDrha:long_name = "Near-surface air relative_humidity from
the ISD collection" ;
            ISDrha:units = "percent" ;
            ISDrha:scale_factor = 0.1f ;
            ISDrha:valid_min = 0.5 ;
            ISDrha:valid_max = 110. ;
            ISDrha:_FillValue = -9999s ;
            ISDrha:description = "Near-surface air relative humidity from
the Integrated Surface Database" ;
            ISDrha:reference = "https://www.ncdc.noaa.gov/isdm, Smith,A.,
N. Lott and R.Vose, 2011: The Integrated Surface Database: Recent
developments and partnerships. Bull. Amer. Meteor. Soc., 92, 704-708,
doi:10.1175/2011BAMS3015.1." ;
      ubyte ISDrhflag(times, eqcell) ;
            ISDrhflag:long_name = "Near-surface air relative humidity
orgin code" ;
            ISDrhflag:flag_values = 1UB, 2UB, 3UB, 4UB, 5UB, 255UB ;
```

```
            ISDrhflag:flag_meaning = "original_value interpolated_value
replicated_value filled_with_2.5_degree filled_with_5.0_degree undefined "
;
      short ISDrhcount(times, eqcell) ;
            ISDrhcount:long_name = "Number of stations used to calculate
the relative humidity average" ;
            ISDrhcount:_FillValue = -9999s ;
            ISDrhcount:units = "1" ;
            ISDrhcount:description = "Number of stations used to calculate
the near surface air relative humidity average for each equal-area grid
cell" ;
      short preciprate(times, eqcell) ;
            preciprate:long_name = "Precipitation rate" ;
            preciprate:units = "mm/hour" ;
            preciprate:_FillValue = -9999s ;
            preciprate:scale_factor = 0.01f ;
            preciprate:_description = "Hourly precipitationitation rate
from merged GPCP and TMPA data" ;
            preciprate:references = "Huffman, G.J., R.F. Adler, M.M.
Morrissey, S. Curtis  \nR. Joyce, B. McGavock, and J. Susskind, 2001:
\n ftp://meso.gfsc.nasa.gov//pub/1dd-v1.\n Global precipitation at one-
degree daily resolution from multi-satellite observations\n
http://pmm.nasa.gov/data-access/downloads/trmm/\n" ;
      short precipratio(times, eqcell) ;
            precipratio:long_name = "Precipitation ratio" ;
            precipratio:units = "1" ;
            precipratio:_FillValue = -9999s ;
            precipratio:valid_max = 1. ;
            precipratio:scale_factor = 0.01f ;
            precipratio:valid_min = 0 ;
            precipratio:description = "Ratio of the precipitation rate
including 0 to the precipitation rate without 0" ;
      ubyte precipoflag(times, eqcell) ;
            precipoflag:long_name = " Precipitation origin flag " ;
            precipoflag:units = "1" ;
            precipoflag:flag_meaning = "TMPA GPCP undefined" ;
            precipoflag:flag_values = 0UB, 1UB, 255UB ;
            precipoflag:description = "Origin flag of the precipitation
data" ;
      ubyte preciptflag(times, eqcell) ;
            preciptflag:long_name = "Precipitation type flag" ;
            preciptflag:units = "1" ;
            preciptflag:_FillValue = 255UB ;
            preciptflag:flag_meaning = "liquid frozen undefined" ;
            preciptflag:flag_values = 0UB, 1UB, 255UB ;
            preciptflag:_description = "Flag indicates whether precipition
for a given cell is liquid or frozen which is determined by air surface
temperature of less then 268 K found in the NNHIRS retrieval" ;
      char lctlabel(low_cloud_type, label_len) ;
            lctlabel:long_name = "Low cloud type labels" ;
            lctlabel:units = "1" ;
            lctlabel:description = "Low cloud type label as determined
where uppermost cloud top pressure is greater than 500 hPa" ;
      short lcfrac(times, eqcell, low_cloud_type) ;
```

```
            lcfrac:long_name = "Low cloud fraction" ;
            lcfrac:units = "1" ;
            lcfrac:valid_min = 0 ;
            lcfrac:valid_max = 1 ;
            lcfrac:_FillValue = -9999s ;
            lcfrac:scale = 0.01 ;
            lcfrac:description = "Low cloud fraction from the ISCCP FD
dataset where cloud top is less than 500 hPa" ;
            lcfrac:reference =
"http://www.ISCCP.giss.nasa.gov/projects/flux.html, , Zhang, Y-C., W.B.
Rossow, A.A. Lacis, M.I. Mishchenko and V. Oinas,\nCalculation of
radiative fluxes from the surface to top-of-atmosphere\nbased on ISCCP and
other global datasets: Refinements of the radiative\ntransfer model and
the input data. J. Geophys. Res., 109, doi\n10.1029/2003JD004457 (1-27 +
1-25), 2004." ;
      short dccfrac(times, eqcell) ;
            dccfrac:long_name = "Deep convective cloud fraction" ;
            dccfrac:units = "1" ;
            dccfrac:valid_min = 0 ;
            dccfrac:valid_max = 1 ;
            dccfrac:_FillValue = -9999s ;
            dccfrac:scale = 0.01 ;
            dccfrac:description = "Cloud fraction from theISCCP FD dataset
where base pressure is less than 440 hPa and cloud opticalthickness is
greater than 23" ;
            dccfrac:reference =
"http://www.ISCCP.giss.nasa.gov/projects/flux.html, , Zhang, Y-C., W.B.
Rossow, A.A. Lacis, M.I. Mishchenko and V. Oinas,\nCalculation of
radiative fluxes from the surface to top-of-atmosphere\nbased on ISCCP and
other global datasets: Refinements of the radiative\ntransfer model and
the input data. J. Geophys. Res., 109, doi\n10.1029/2003JD004457 (1-27 +
1-25), 2004." ;
      short clbasep(times, eqcell) ;
            clbasep:long_name = "Lowermost cloud base pressure" ;
            clbasep:units = "hPa" ;
            clbasep:scale_factor = 0.01f ;
            clbasep:_FillValue = -9999s ;
            clbasep:valid_min = 10. ;
            clbasep:valid_max = 1019. ;
            clbasep:description = "Lower most cloud base pressure where
cloud top is less than 500 hPa" ;
            clbasep:reference =
"http://www.ISCCP.giss.nasa.gov/projects/flux.html" ;
      short cltopp(times, eqcell) ;
            cltopp:long_name = "Uppermost cloud top pressure" ;
            cltopp:units = "hPa" ;
            cltopp:scale_factor = 0.01f ;
            cltopp:_FillValue = -9999s ;
            cltopp:valid_min = 10. ;
            cltopp:valid_max = 1019. ;
            cltopp:description = "Upper most cloud top pressure where
cloud top is less than 500 hPa" ;
```

```
            cltopp:reference =
"http://www.ISCCP.giss.nasa.gov/projects/flux.html,, Zhang, Y-C., W.B.
Rossow, A.A. Lacis, M.I. Mishchenko and V. Oinas,\nCalculation of
radiative fluxes from the surface to top-of-atmosphere\nbased on ISCCP and
other global datasets: Refinements of the radiative\ntransfer model and
the input data. J. Geophys. Res., 109, doi\n10.1029/2003JD004457 (1-27 +
1-25), 2004. " ;
      short totclfrac(times, eqcell) ;
            totclfrac:long_name = "Total cloud fraction" ;
            totclfrac:units = "1" ;
            totclfrac:scale_factor = 0.01f ;
            totclfrac:_FillValue = -9999s ;
            totclfrac:valid_min = 0 ;
            totclfrac:valid_max = 1. ;
            totclfrac:description = "Total Cloud Fraction form the ISCCP
FD dataset" ;
            totclfrac:reference =
"http://www.ISCCP.giss.nasa.gov/projects/flux.html,, Zhang, Y-C., W.B.
Rossow, A.A. Lacis, M.I. Mishchenko and V. Oinas,\nCalculation of
radiative fluxes from the surface to top-of-atmosphere\nbased on ISCCP and
other global datasets: Refinements of the radiative\ntransfer model and
the input data. J. Geophys. Res., 109, doi\n10.1029/2003JD004457 (1-27 +
1-25), 2004. " ;
      float swsurfflux(times, eqcell) ;
            swsurfflux:long_name = "Net short wave surface flux" ;
            swsurfflux:units = "W/ m^2" ;
            swsurfflux:_FillValue = -9999.f ;
            swsurfflux:Description = "Full sky surface short wave flux up
- full sky surface short wave flux down" ;
            swsurfflux:reference =
"http://www.ISCCP.giss.nasa.gov/projects/flux.html, , Zhang, Y-C., W.B.
Rossow, A.A. Lacis, M.I. Mishchenko and V. Oinas,\nCalculation of
radiative fluxes from the surface to top-of-atmosphere\nbased on ISCCP and
other global datasets: Refinements of the radiative\ntransfer model and
the input data. J. Geophys. Res., 109, doi\n10.1029/2003JD004457 (1-27 +
1-25), 2004." ;
      float lwsurfflux(times, eqcell) ;
            lwsurfflux:long_name = "Net long wave surface flux" ;
            lwsurfflux:units = "W/ m^2" ;
            lwsurfflux:_FillValue = -9999.f ;
            lwsurfflux:Description = "Full sky surface Long wave flux up -
full sky surface Long wave flux down" ;
            lwsurfflux:reference =
"http://www.ISCCP.giss.nasa.gov/projects/flux.html, , Zhang, Y-C., W.B.
Rossow, A.A. Lacis, M.I. Mishchenko and V. Oinas,\nCalculation of
radiative fluxes from the surface to top-of-atmosphere\nbased on ISCCP and
other global datasets: Refinements of the radiative\ntransfer model and
the input data. J. Geophys. Res., 109, doi\n10.1029/2003JD004457 (1-27 +
1-25), 2004." ;
      float sw680flux(times, eqcell) ;
            sw680flux:long_name = "Net short Wwave flux at 680 hPa" ;
            sw680flux:units = "W/ m^2" ;
            sw680flux:_FillValue = -9999.f ;
```

```
            sw680flux:Description = "Full sky short wave flux down - full
short wave flux up at 680 hPa" ;
            sw680flux:reference =
"http://www.ISCCP.giss.nasa.gov/projects/flux.html,, Zhang, Y-C., W.B.
Rossow, A.A. Lacis, M.I. Mishchenko and V. Oinas,\nCalculation of
radiative fluxes from the surface to top-of-atmosphere\nbased on ISCCP and
other global datasets: Refinements of the radiative\ntransfer model and
the input data. J. Geophys. Res., 109, doi\n10.1029/2003JD004457 (1-27 +
1-25), 2004. " ;
      float lw680flux(times, eqcell) ;
            lw680flux:long_name = "Net long wave flux at 680 hPa" ;
            lw680flux:units = "W/ m^2" ;
            lw680flux:_FillValue = -9999.f ;
            lw680flux:Description = "Full sky Long wave flux down - full
sky Long wave flux up at 680 hPa" ;
            lw680flux:reference =
"http://www.ISCCP.giss.nasa.gov/projects/flux.html, , Zhang, Y-C., W.B.
Rossow, A.A. Lacis, M.I. Mishchenko and V. Oinas,\nCalculation of
radiative fluxes from the surface to top-of-atmosphere\nbased on ISCCP and
other global datasets: Refinements of the radiative\ntransfer model and
the input data. J. Geophys. Res., 109, doi\n10.1029/2003JD004457 (1-27 +
1-25), 2004." ;
      short FDta(times, eqcell) ;
            FDta:long_name = "Near-surface air temperature from the FD
dataset" ;
            FDta:units = "Kelvin" ;
            FDta:scale_factor = 0.1 ;
            FDta:valid_min = 160 ;
            FDta:valid_max = 350 ;
            FDta:_FillValue = -9999s ;
            FDta:Description = "Near-surface air temperature from the FD
dataset" ;
            FDta:reference =
"http://www.ISCCP.giss.nasa.gov/projects/flux.html, , Zhang, Y-C., W.B.
Rossow, A.A. Lacis, M.I. Mishchenko and V. Oinas,\nCalculation of
radiative fluxes from the surface to top-of-atmosphere\nbased on ISCCP and
other global datasets: Refinements of the radiative\ntransfer model and
the input data. J. Geophys. Res., 109, doi\n10.1029/2003JD004457 (1-27 +
1-25), 2004." ;
      float ET_tran_liquid(eqcell) ;
            ET_tran_liquid:long_name = "Contribution to ET from
transpiration" ;
            ET_tran_liquid:units = "W/m2" ;
            ET_tran_liquid:_FillValue = -9999.f ;
            ET_tran_liquid:reference =
"http://hydrology.priceton.edu/data/landflux/et_prod" ;
      float ET_soil_liquid(eqcell) ;
            ET_soil_liquid:long_name = "Contribution to ET from soil
evaporation" ;
            ET_soil_liquid:units = "W/m2" ;
            ET_soil_liquid:_FillValue = -9999.f ;
```

```
            ET_soil_liquid:reference =
"http://hydrology.priceton.edu/data/landflux/et_prod" ;
      float ET_water_liquid(eqcell) ;
            ET_water_liquid:long_name = "Contribution to ET from open
water" ;
            ET_water_liquid:units = "W/m2" ;
            ET_water_liquid:_FillValue = -9999.f ;
            ET_water_liquid:reference =
"http://hydrology.priceton.edu/data/landflux/et_prod" ;
      float can_evap_liquid(eqcell) ;
            can_evap_liquid:long_name = "Evaporation from wet canopy" ;
            can_evap_liquid:units = "W/m2" ;
            can_evap_liquid:_FillValue = -9999.f ;
            can_evap_liquid:reference =
"http://hydrology.priceton.edu/data/landflux/et_prod" ;
      float ET_snow_liquid(eqcell) ;
            ET_snow_liquid:long_name = "Evaporation from snow" ;
            ET_snow_liquid:units = "W/m2" ;
            ET_snow_liquid:_FillValue = -9999.f ;
            ET_snow_liquid:reference =
"http://hydrology.priceton.edu/data/landflux/et_prod" ;
      ubyte ET_type_flag(eqcell) ;
            ET_type_flag:long_name = "ET type flag" ;
            ET_type_flag:units = "1" ;
            ET_type_flag:flag_meaning = "liquid frozen undefined" ;
            ET_type_flag:flag_values = 0UB, 1UB, 255UB ;
            ET_type_flag:_description = "Flag indicates whether ET for a
given cell is liquid or frozen which is determined by a daily air surface
temperature of less then 268 K found in the NNHIRS retrieval" ;

// global attributes:
            :Conventions = "CF-1.4" ;
            :title = "Land Surface Meteorology data" ;
            :author = "William B. Rossow" ;
            :producer = "William B. Rossow" ;
            :institution = "The City College of New York NOAA/CREST" ;
            :first_release_date = "November 2016" ;
            :source = "Multiple Observational Sources" ;
            :citation = "TBD" ;
            :references = "TBD" ;
            :identifier_product_DOI = "10.5067/MEASURES/LANDMET/DATA001" ;
            :identifier_product_DOI_authority = "http://dx.doi.org/" ;
            :comment = "Version one produced at CCNY" ;
            :processing_level = "3" ;
            :range_beginning_time = "00:00:00" ;
            :range_ending_time = "23:59:59" ;
            :short_name = "LANDMET" ;
            :long_name = "Land Surface Atmospheric Boundary Interaction
Product L3" ;
            :format = "netCDF-4 classic" ;
            :version_id = "1" ;
            :year = 2003 ;
            :month = 1 ;
            :day = 1 ;
```

```
            :production_run_date = "2016-11-16" ;
            :production_run_time = "08:29:31" ;
            :range_beginning_date = "2003-01-01" ;
            :range_ending_date = "2003-01-01" ;
            :granule_id = "landmet_L3_20030101_v1.nc" ;
}
```

8. Appendix – Sample Images for Each Variable from 2003 01 01

By applying the following pseudo code an equal-area grid image can be represented as an equal-angle grid.

Retrieve variables from the netcdf file (In this example the physical variable is ttrop):

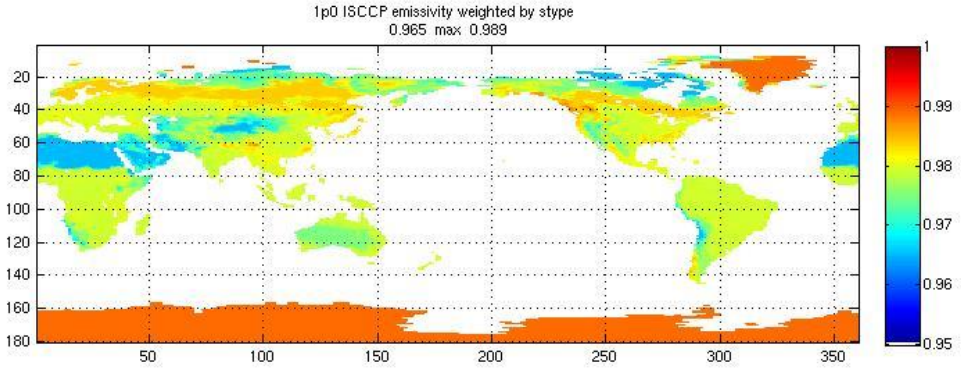
```
sqlon_beg,
sqlon_end,
eqlat_index
eqcell
ttrop

do icell=1,eqcell
  ilon1 = sqlon_beg(icell)
  ilon2 = sqlon_end(icell)
  ilat = eqlat_index(icell)
    do i=ilon1,ilon2
     sqmap(i,ilat) = ttrop(icell)
    enddo
enddo
```

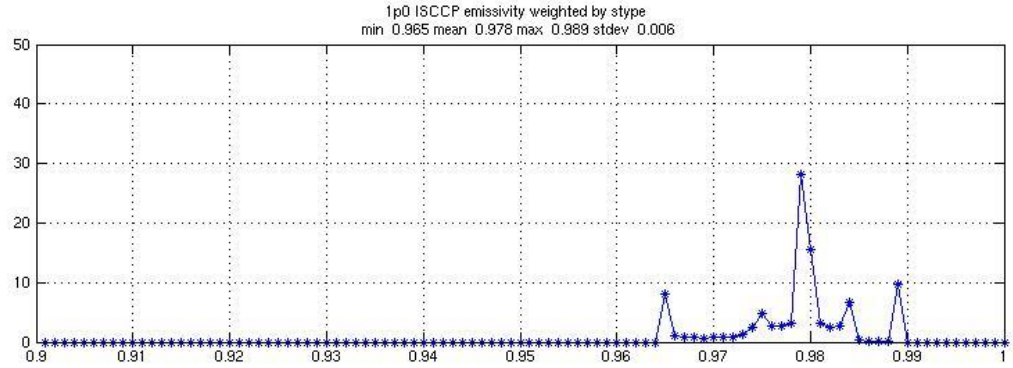
The variable *sqmap(360,180)* can now be displayed in equal angle format.

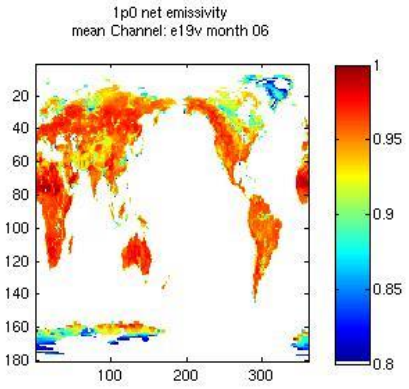
The following figures show1equal angle map and one histogram for each equal area grid variable found in the 20030101 LandMet netcdf file and the ancillary files.

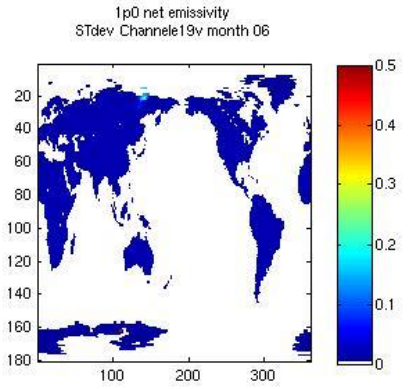
ALL Figures are for 20030101

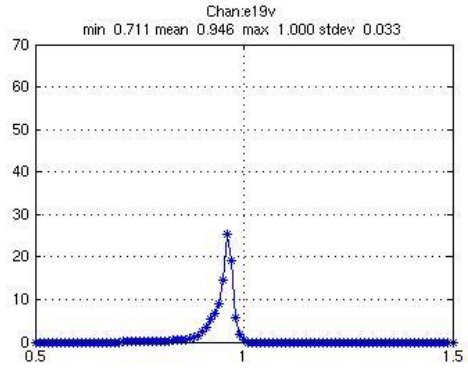
Emissivity ancillary file:

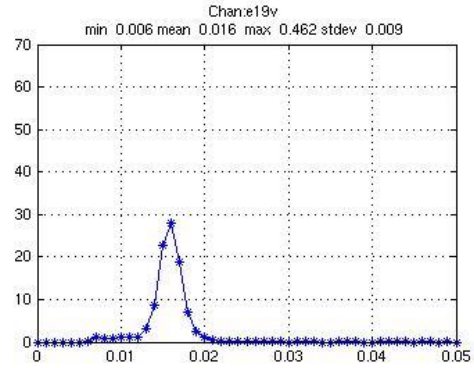

1p0 ISCCP emissivity weighted by stype
0.965 max 0.989
20
40
60
80
100
120
140
160
180
50
100
150
200
250
300
350
1
0.99
0.98
0.97
0.96
0.95

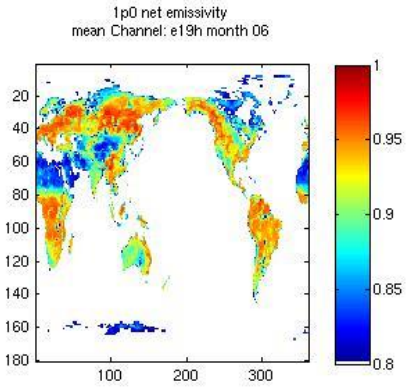

1p0 ISCCP emissivity weighted by stype
min 0.965 mean 0.978 max 0.989 stdev 0.006
50
40
30
20
10
0
0.9
0.91
0.92
0.93
0.94
0.95
0.96
0.97
0.98
0.99
1

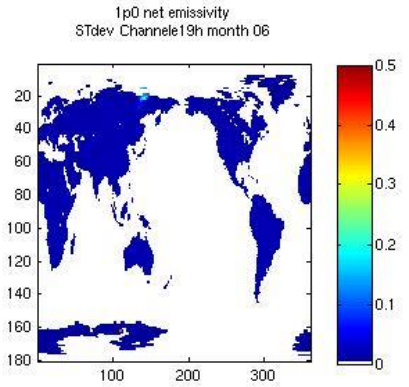

1p0 net emissivity
mean Channel: e19v month 06
20
40
60
80
100
120
140
160
180
100
200
300
1
0.95
0.9
0.85
0.8

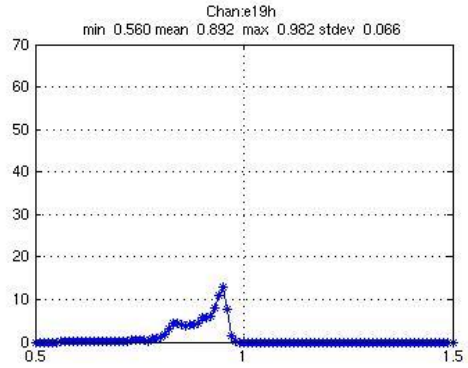

1p0 net emissivity
STdev Channele19v month 06
20
40
60
80
100
120
140
160
180
100
200
300
0.5
0.4
0.3
0.2
0.1
0

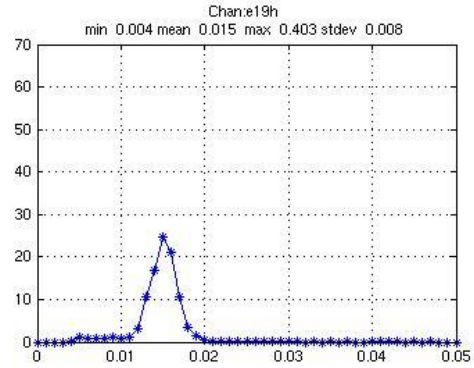

Chan:e19v
min 0.711 mean 0.946 max 1.000 stdev 0.033
70
60
50
40
30
20
10
0
0.5
1
1.5

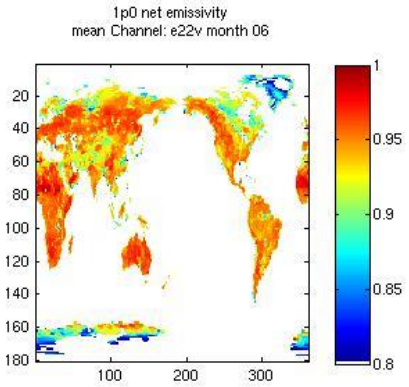

Chan:e19v
min 0.006 mean 0.016 max 0.462 stdev 0.009
70
60
50
40
30
20
10
0
0
0.01
0.02
0.03
0.04
0.05

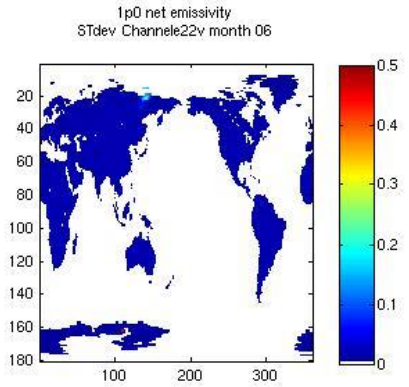

1p0 net emissivity
mean Channel: e19h month 06
20
40
60
80
100
120
140
160
180
100
200
300
1
0.95
0.9
0.85
0.8

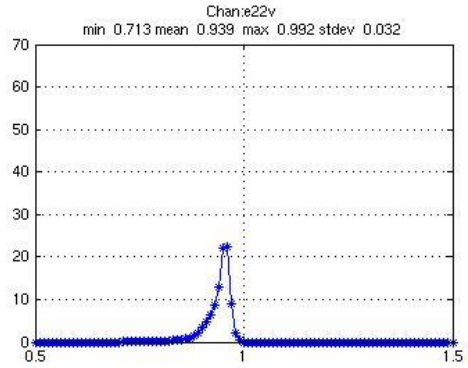

1p0 net emissivity
STdev Channele19h month 06
20
40
60
80
100
120
140
160
180
100
200
300
0.5
0.4
0.3
0.2
0.1
0

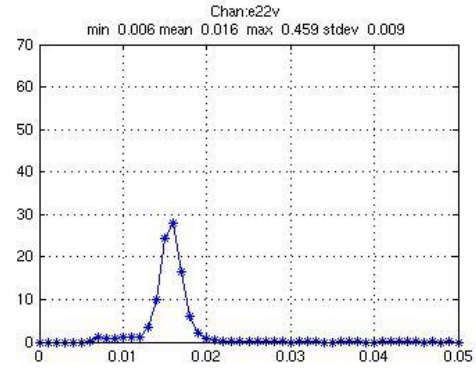

Chan:e19h
min 0.560 mean 0.892 max 0.982 stdev 0.066
70
60
50
40
30
20
10
0
0.5
1
1.5

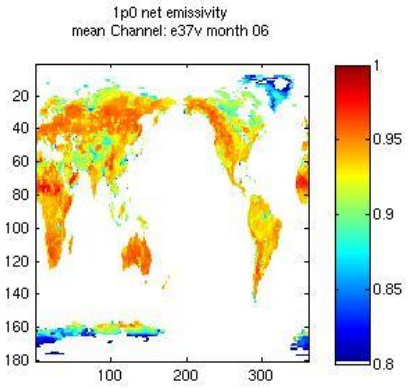

Chan:e19h
min 0.004 mean 0.015 max 0.403 stdev 0.008
70
60
50
40
30
20
10
0
0
0.01
0.02
0.03
0.04
0.05

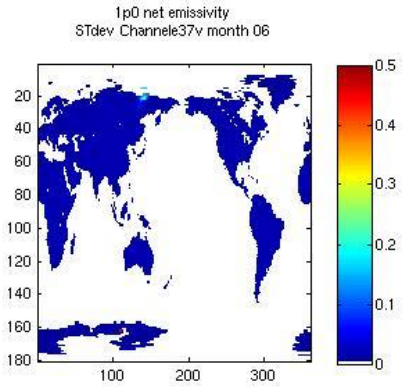

1p0 net emissivity
mean Channel: e22v month 06
20
40
60
80
100
120
140
160
180
100
200
300
1
0.95
0.9
0.85
0.8

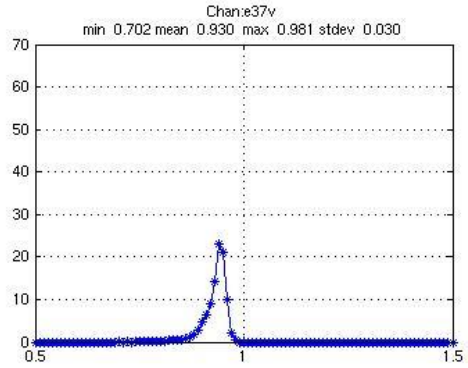

1p0 net emissivity
STdev Channele22v month 06
20
40
60
80
100
120
140
160
180
100
200
300
0.5
0.4
0.3
0.2
0.1
0

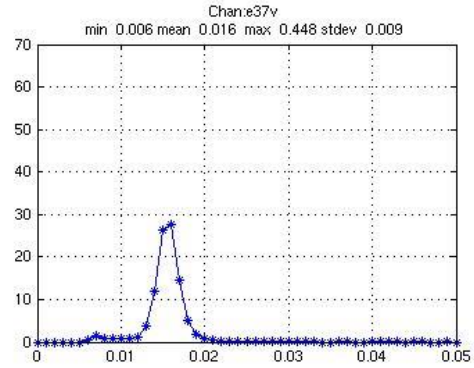

Chan:e22v
min 0.713 mean 0.939 max 0.992 stdev 0.032
70
60
50
40
30
20
10
0
0.5
1
1.5


Chan:e22v
min 0.006 mean 0.016 max 0.459 stdev 0.009
70
60
50
40
30
20
10
0
0
0.01
0.02
0.03
0.04
0.05


1p0 net emissivity
mean Channel: e37v month 06
20
40
60
80
100
120
140
160
180
100
200
300
1
0.95
0.9
0.85
0.8


1p0 net emissivity
STdev Channele37v month 06
20
40
60
80
100
120
140
160
180
100
200
300
0.5
0.4
0.3
0.2
0.1
0


Chan:e37v
min 0.702 mean 0.930 max 0.981 stdev 0.030
70
60
50
40
30
20
10
0
0.5
1
1.5


Chan:e37v
min 0.006 mean 0.016 max 0.448 stdev 0.009
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60
50
40
30
20
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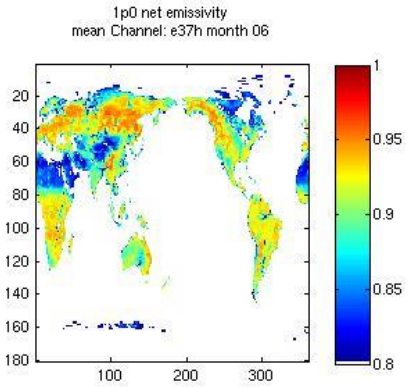
0.01
0.02
0.03
0.04
0.05


1p0 net emissivity
mean Channel: e37h month 06
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40
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100
120
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160
180
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200
300
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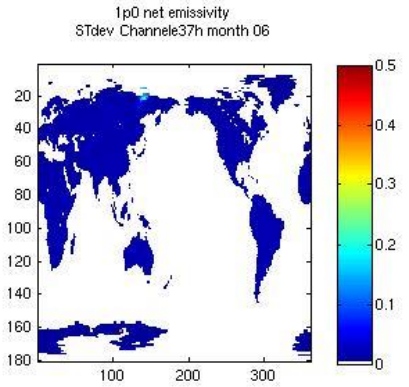
0.85
0.8


1p0 net emissivity
STdev Channele37h month 06
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120
140
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100
200
300
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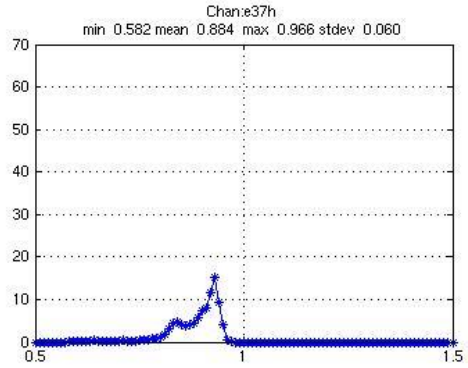
0.4
0.3
0.2
0.1
0


Chan:e37h
min 0.582 mean 0.884 max 0.966 stdev 0.060
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30
20
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0.5
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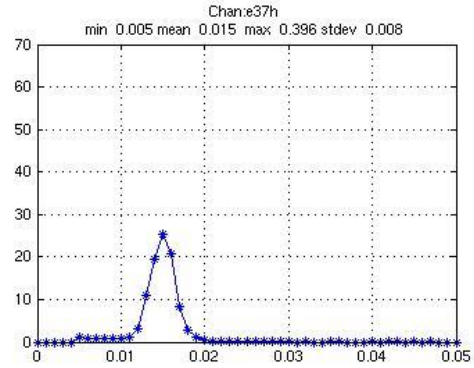
1.5


Chan:e37h
min 0.005 mean 0.015 max 0.396 stdev 0.008
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30
20
10
0
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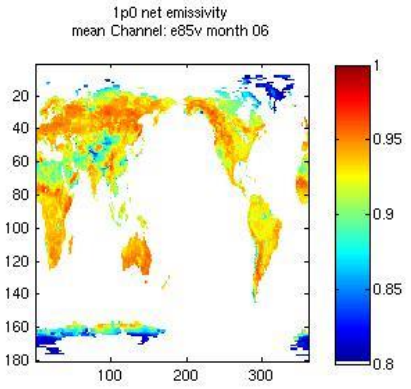
0.01
0.02
0.03
0.04
0.05


1p0 net emissivity
mean Channel: e85v month 06
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80
100
120
140
160
180
100
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300
1
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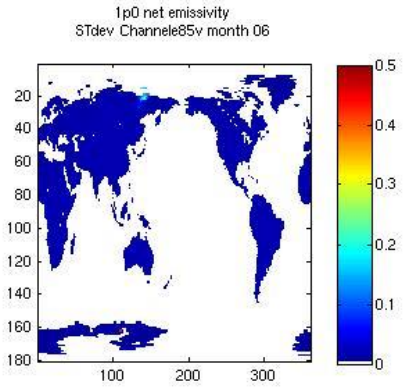
0.9
0.85
0.8


1p0 net emissivity
STdev Channele85v month 06
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120
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100
200
300
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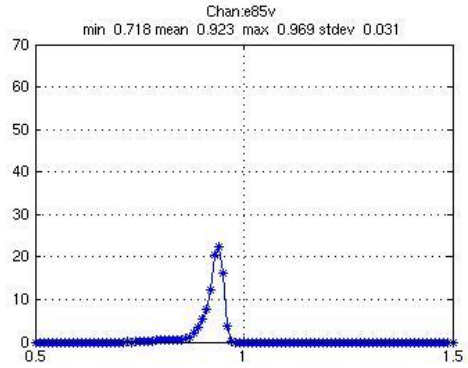
0.4
0.3
0.2
0.1
0


Chan:e85v
min 0.718 mean 0.923 max 0.969 stdev 0.031
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60
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0.5
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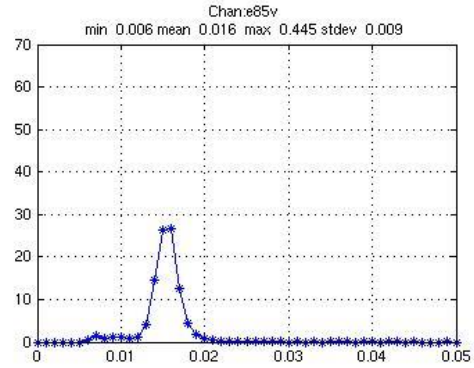
1.5


Chan:e85v
min 0.006 mean 0.016 max 0.445 stdev 0.009
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40
30
20
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0
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0.01
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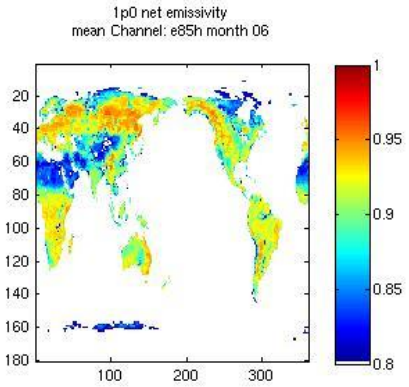
0.03
0.04
0.05


1p0 net emissivity
mean Channel: e85h month 06
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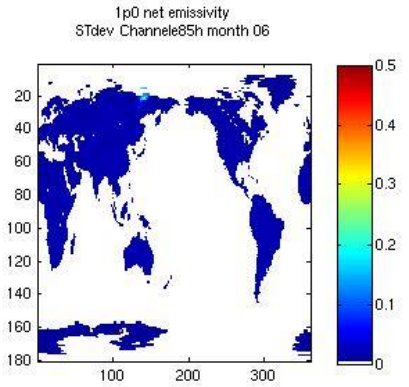
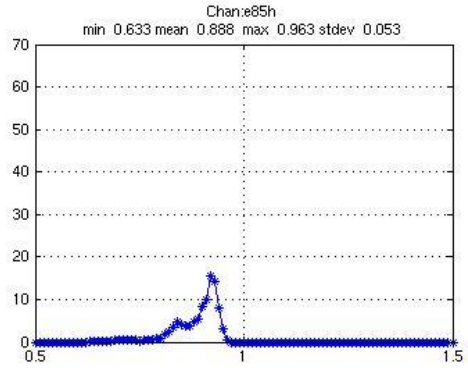
100
120
140
160
180
100
200
300
1
0.95
0.9
0.85
0.8


1p0 net emissivity
STdev Channele85h month 06
20
40
60
80
100
120
140
160
180
100
200
300
0.5
0.4
0.3
0.2
0.1
0


Chan:e85h
min 0.633 mean 0.888 max 0.963 stdev 0.053
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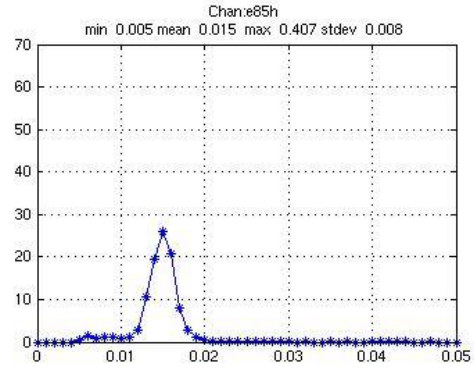
60
50
40
30
20
10
0
0.5
1
1.5


Chan:e85h
min 0.005 mean 0.015 max 0.407 stdev 0.008
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60
50
40
30
20
10
0
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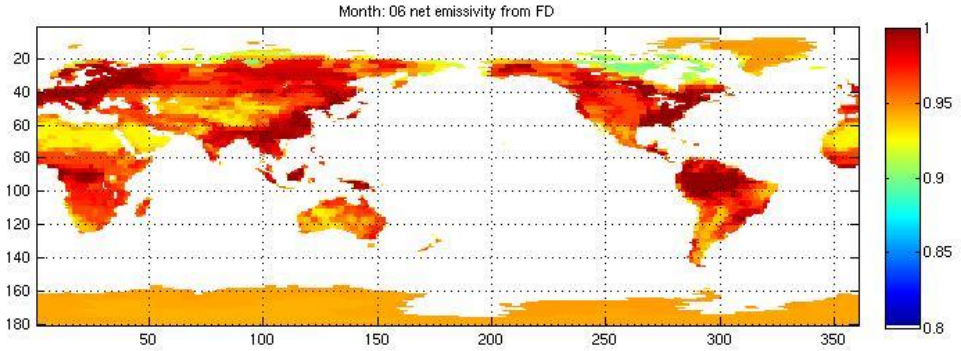
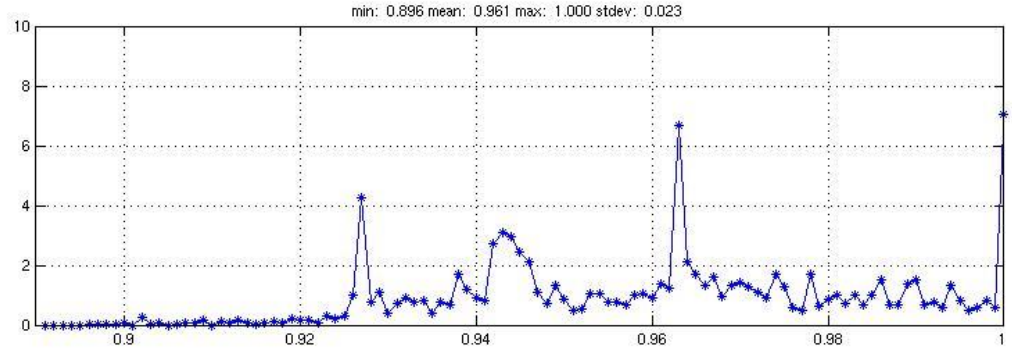
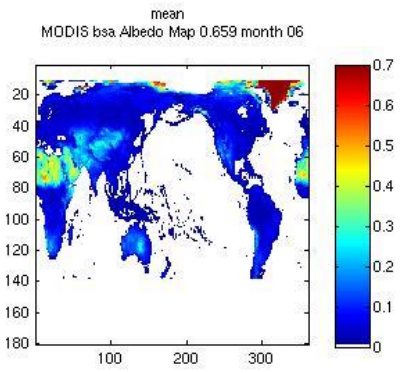
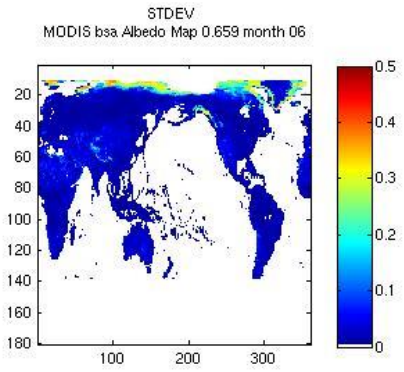
0.01
0.02
0.03
0.04
0.05

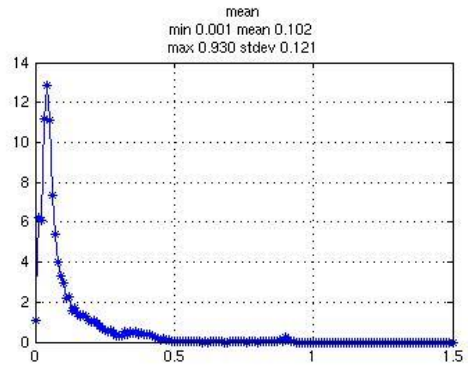


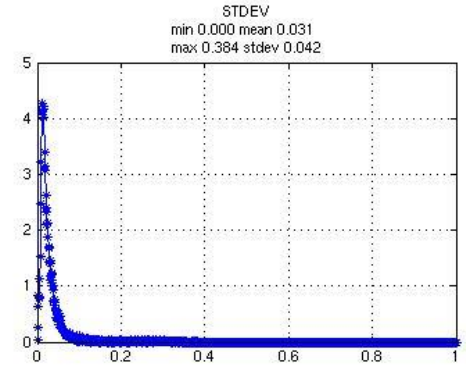


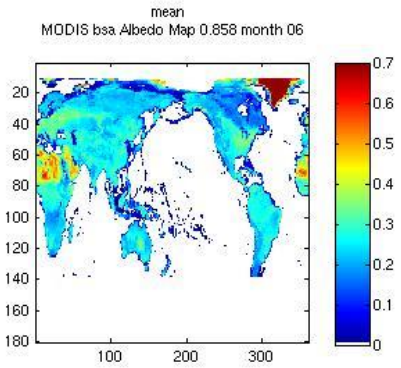
Ancillary Albedo

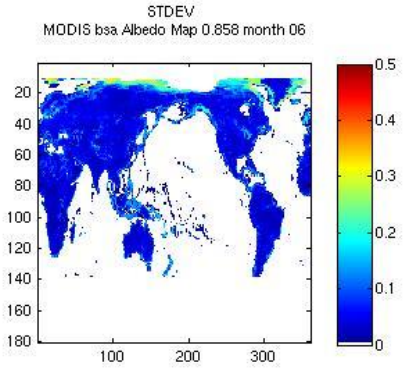

mean
MODIS bsa Albedo Map 0.659 month 06
20
40
60
80
100
120
140
160
180
100
200
300
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

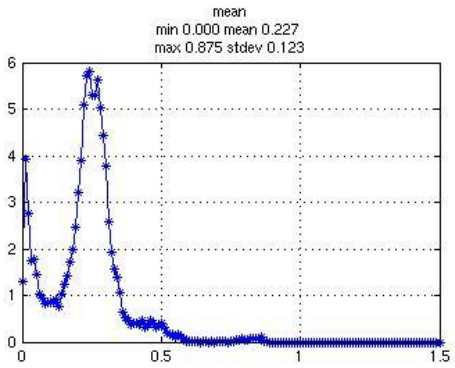

STDEV
MODIS bsa Albedo Map 0.659 month 06
20
40
60
80
100
120
140
160
180
100
200
300
0.5
0.4
0.3
0.2
0.1
0

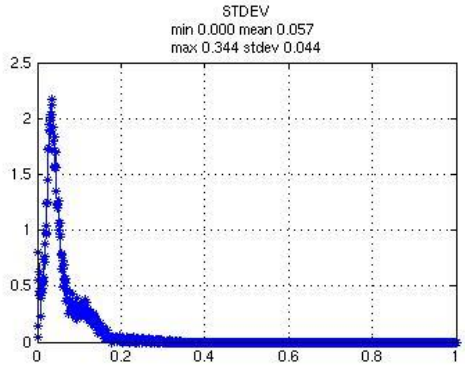

mean
min 0.001 mean 0.102
max 0.930 stdev 0.121
14
12
10
8
6
4
2
0
0
0.5
1
1.5

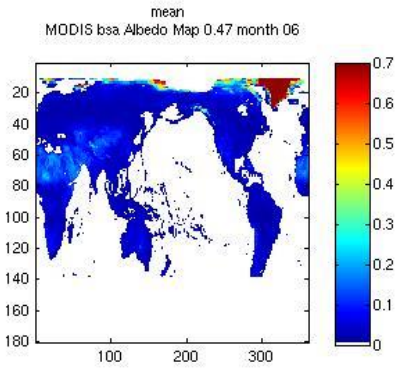

STDEV
min 0.000 mean 0.031
max 0.384 stdev 0.042
5
4
3
2
1
0
0
0.2
0.4
0.6
0.8
1

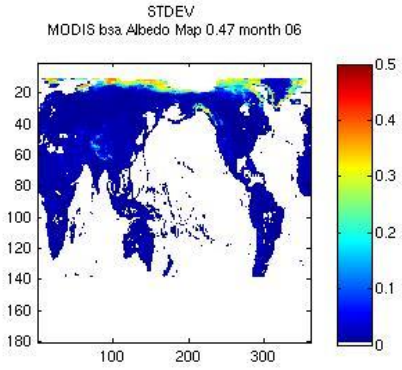

mean
MODIS bsa Albedo Map 0.858 month 06

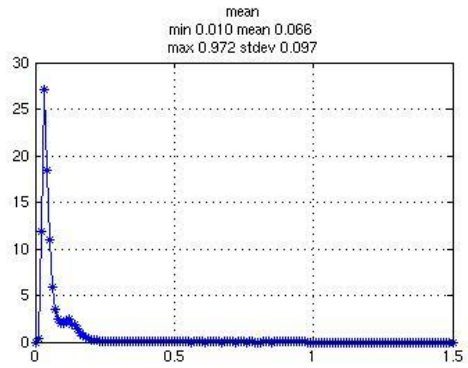

STDEV
MODIS bsa Albedo Map 0.858 month 06

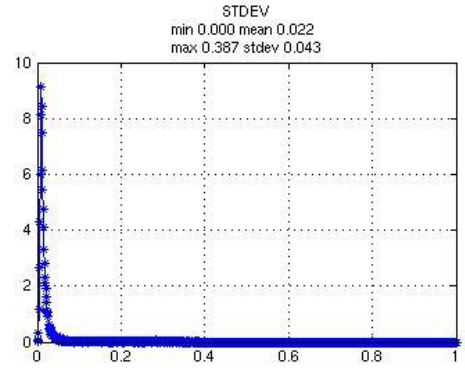

mean
min 0.000 mean 0.227
max 0.875 stdev 0.123

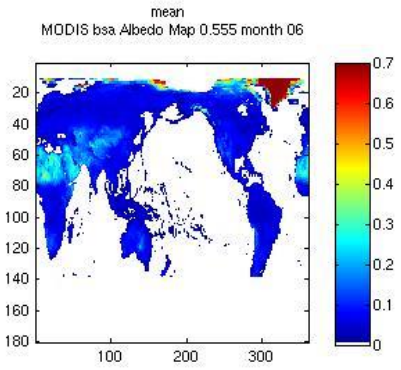

STDEV
min 0.000 mean 0.057
max 0.344 stdev 0.044

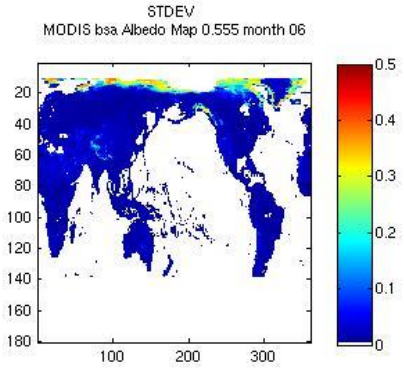

mean
MODIS bsa Albedo Map 0.47 month 06
20
40
60
80
100
120
140
160
180
100
200
300
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

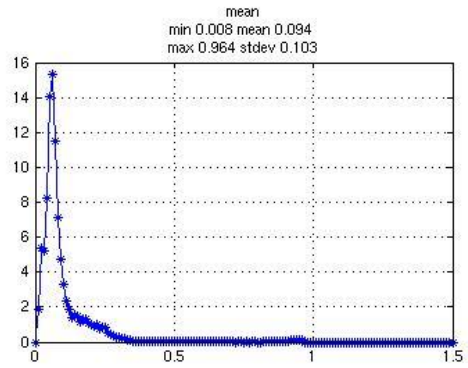

STDEV
MODIS bsa Albedo Map 0.47 month 06
20
40
60
80
100
120
140
160
180
100
200
300
0.5
0.4
0.3
0.2
0.1
0

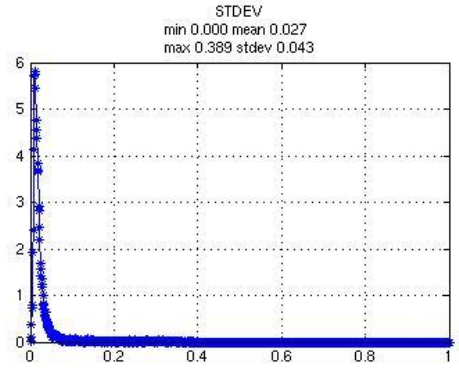

mean
min 0.010 mean 0.066
max 0.972 stdev 0.097
30
25
20
15
10
5
0
0
0.5
1
1.5

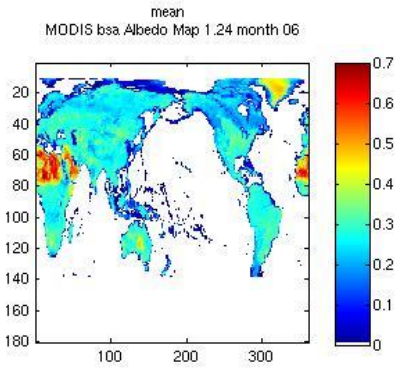

STDEV
min 0.000 mean 0.022
max 0.387 stdev 0.043
10
8
6
4
2
0
0
0.2
0.4
0.6
0.8
1

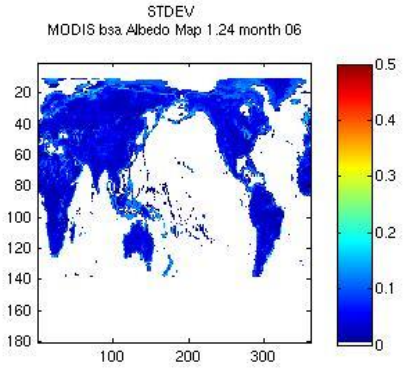

mean
MODIS bsa Albedo Map 0.555 month 06


STDEV
MODIS bsa Albedo Map 0.555 month 06


mean
min 0.008 mean 0.094
max 0.964 stdev 0.103


STDEV
min 0.000 mean 0.027
max 0.389 stdev 0.043


mean
MODIS bsa Albedo Map 1.24 month 06
20
40
60
80
100
120
140
160
180
100
200
300
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0


STDEV
MODIS bsa Albedo Map 1.24 month 06
20
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60
80
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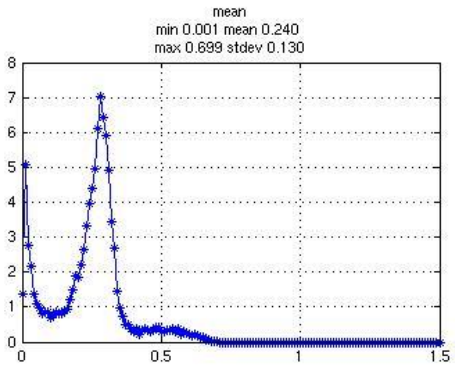
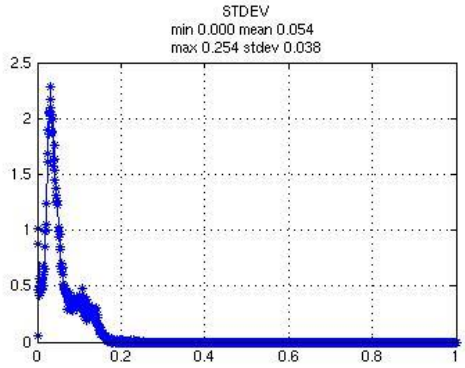
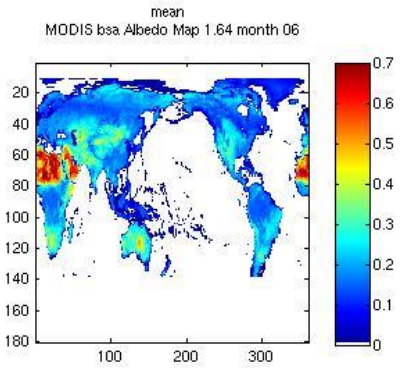
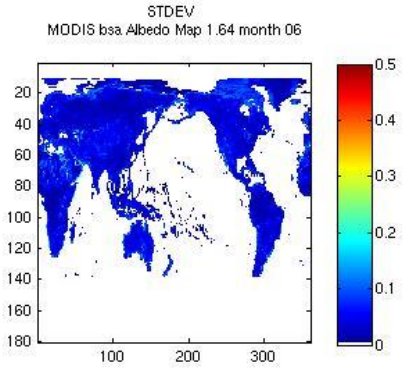
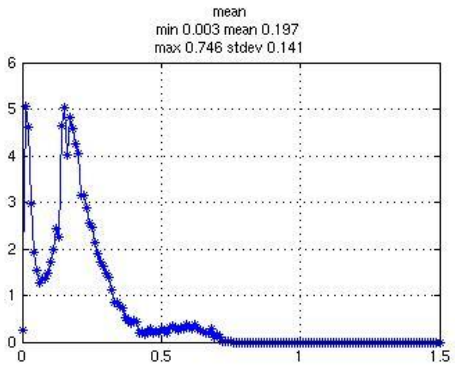
120
140
160
180
100
200
300
0.5
0.4
0.3
0.2
0.1
0

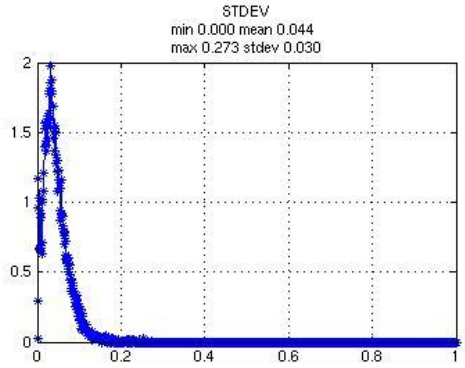

mean
min 0.001 mean 0.240
max 0.699 stdev 0.130
8
7
6
5
4
3
2
1
0
0
0.5
1
1.5

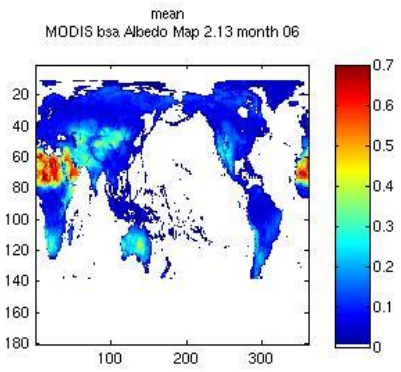

STDEV
min 0.000 mean 0.054
max 0.254 stdev 0.038
2.5
2
1.5
1
0.5
0
0
0.2
0.4
0.6
0.8
1

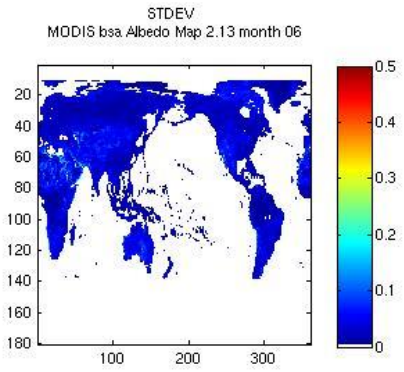

mean
MODIS bsa Albedo Map 1.64 month 06

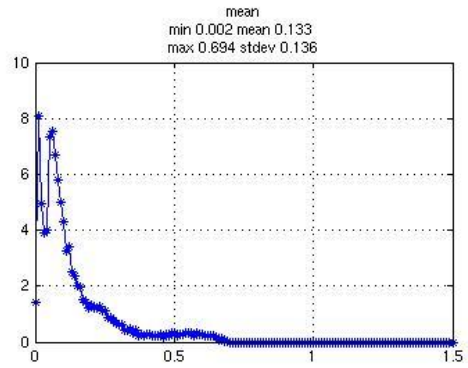

STDEV
MODIS bsa Albedo Map 1.64 month 06

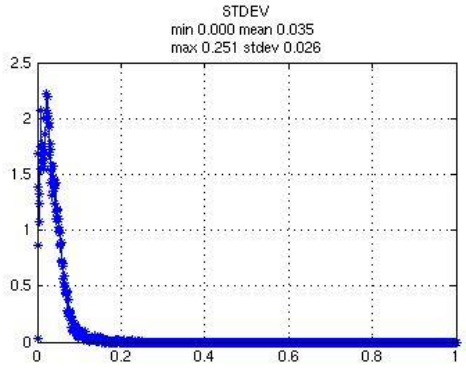

mean
min 0.003 mean 0.197
max 0.746 stdev 0.141

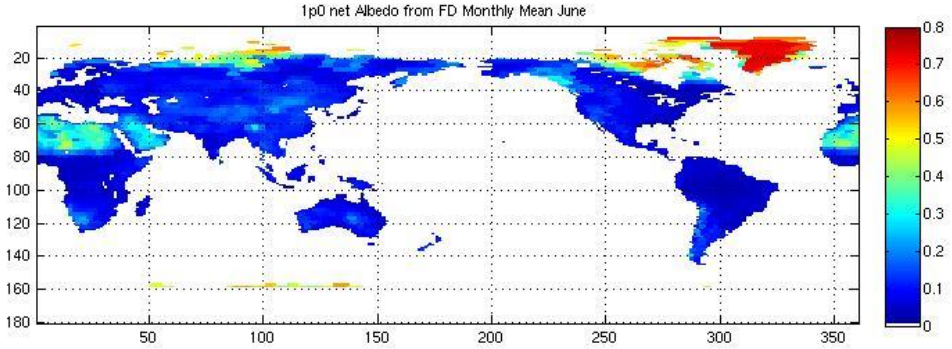

STDEV
min 0.000 mean 0.044
max 0.273 stdev 0.030

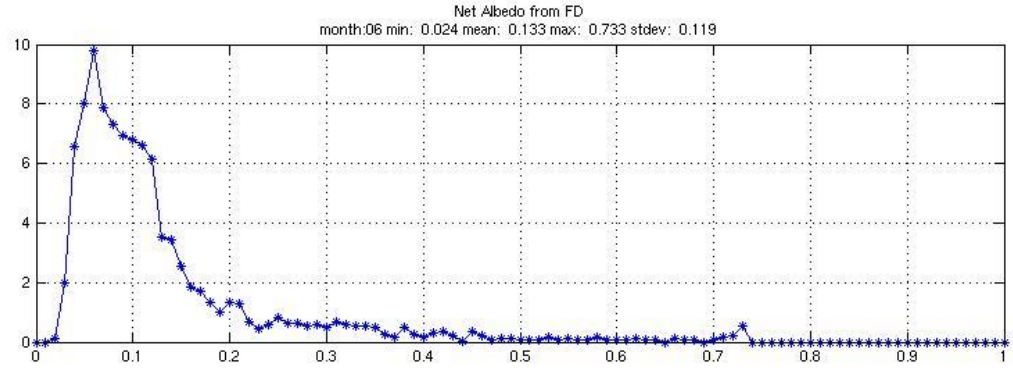

mean
MODIS bsa Albedo Map 2.13 month 06
20
40
60
80
100
120
140
160
180
100
200
300
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0


STDEV
MODIS bsa Albedo Map 2.13 month 06
20
40
60
80
100
120
140
160
180
100
200
300
0.5
0.4
0.3
0.2
0.1
0

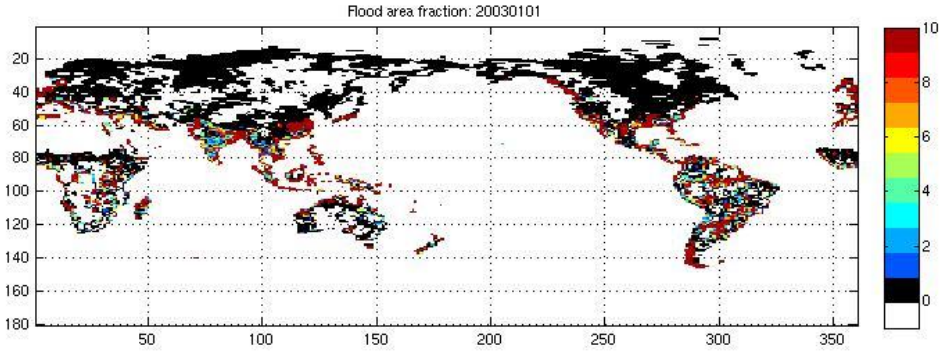

mean
min 0.002 mean 0.133
max 0.694 stdev 0.136
10
8
6
4
2
0
0
0.5
1
1.5

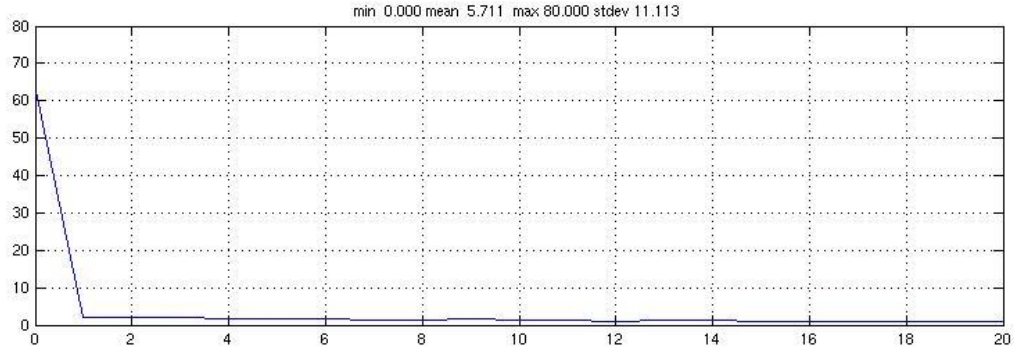

STDEV
min 0.000 mean 0.035
max 0.251 stdev 0.026
2.5
2
1.5
1
0.5
0
0
0.2
0.4
0.6
0.8
1

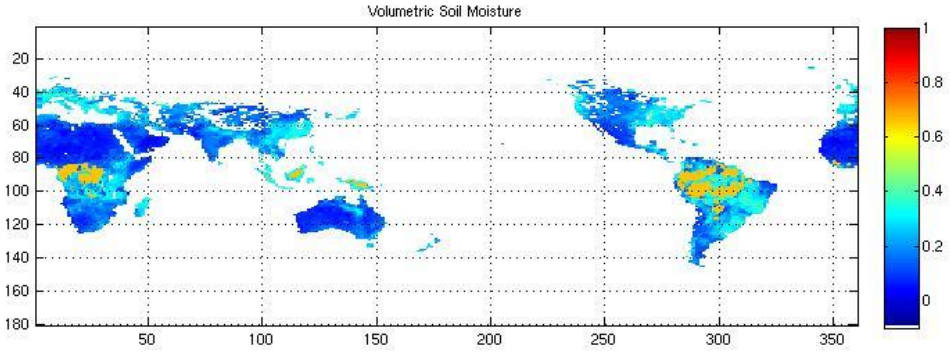


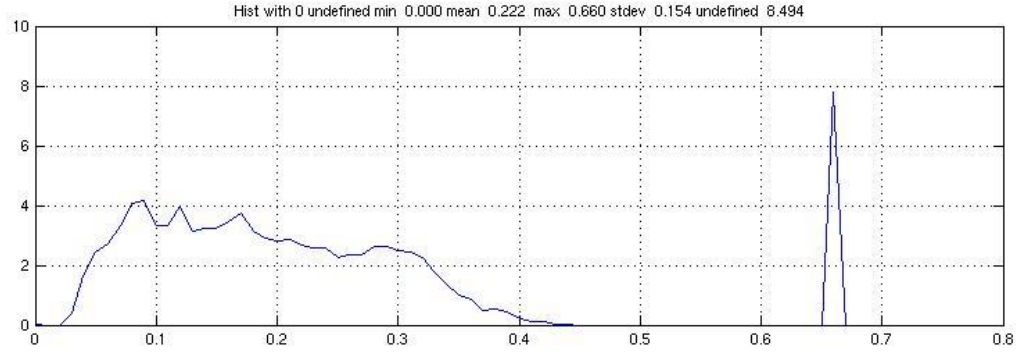


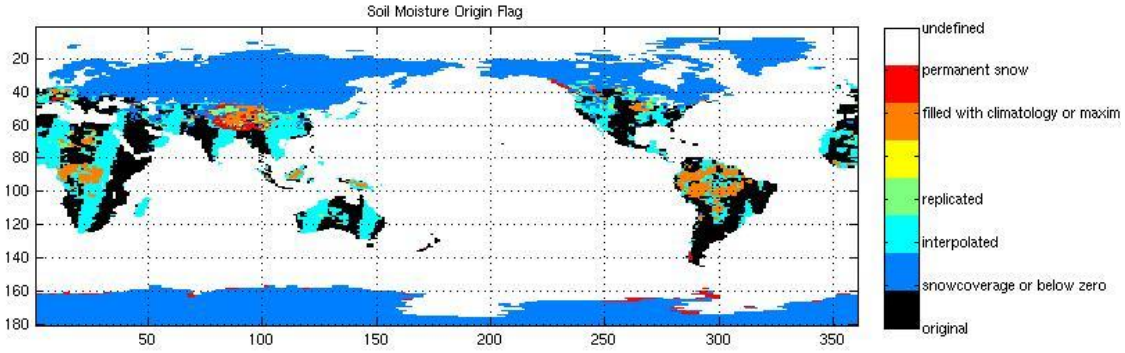
LandMet netcdf File:

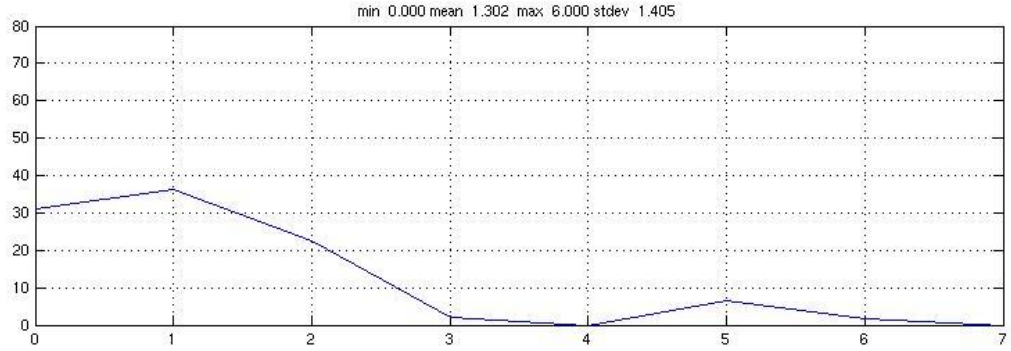

Flood area fraction: 20030101
20
40
60
80
100
120
140
160
180
50
100
150
200
250
300
350
10
8
6
4
2
0

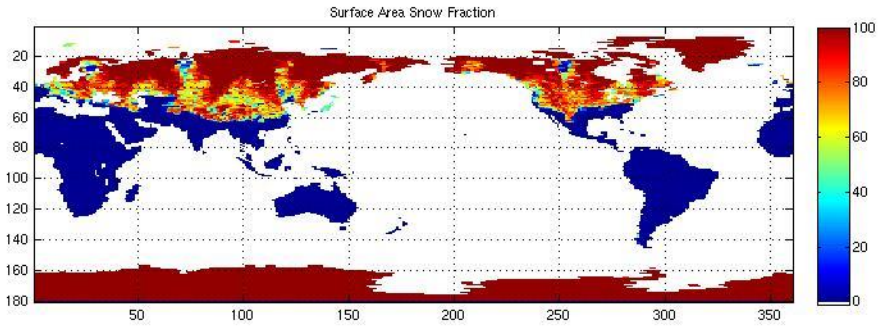

min 0.000 mean 5.711 max 80.000 stdev 11.113
80
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
16
18
20

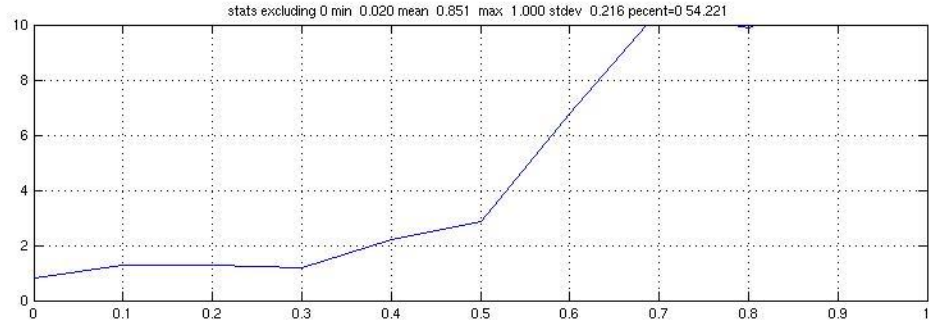

Volumetric Soil Moisture
20
40
60
80
100
120
140
160
180
50
100
150
200
250
300
350
1
0.8
0.6
0.4
0.2
0

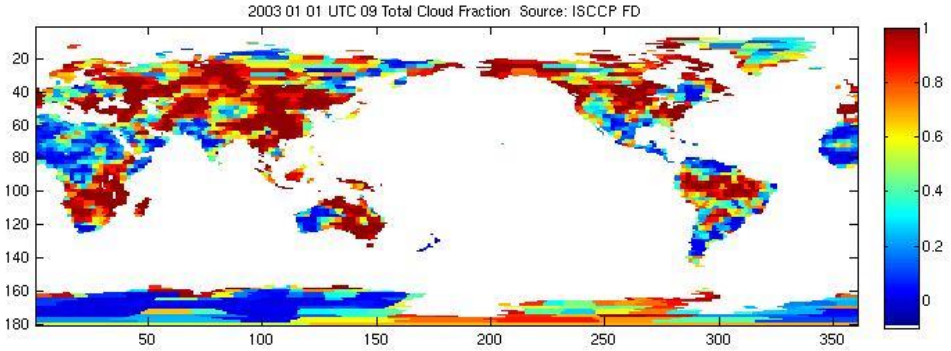

Hist with 0 undefined min 0.000 mean 0.222 max 0.660 stdev 0.154 undefined 8.494
10
8
6
4
2
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8

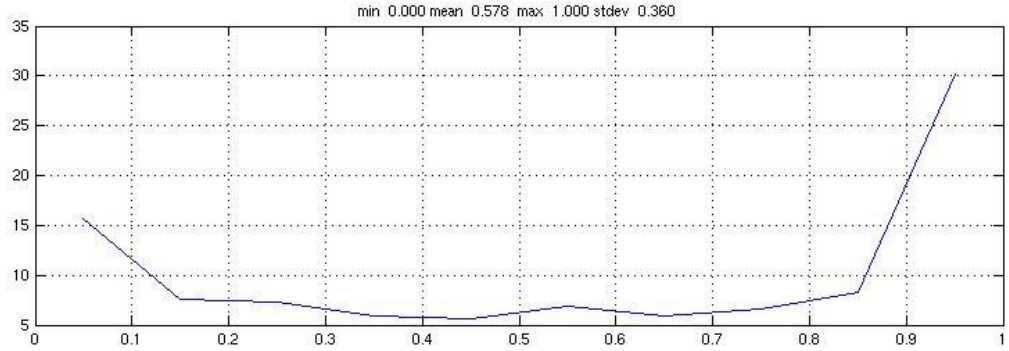

Soil Moisture Origin Flag
undefined
permanent snow
filled with climatology or maxim
replicated
interpolated
snowcoverage or below zero
original
20
40
60
80
100
120
140
160
180
50
100
150
200
250
300
350

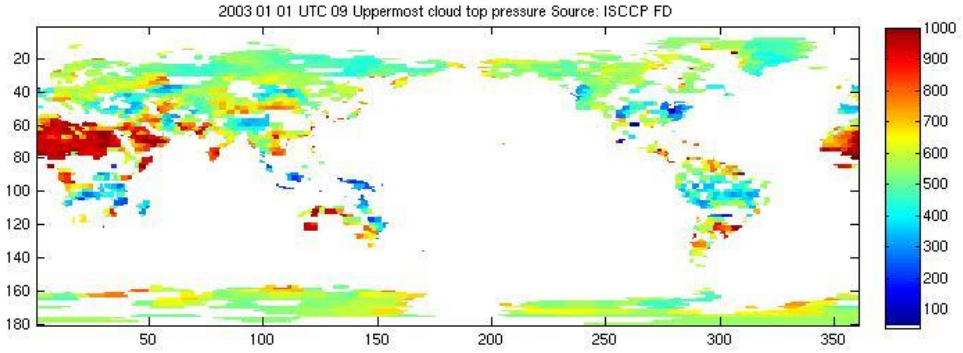

min 0.000 mean 1.302 max 6.000 stdev 1.405
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7

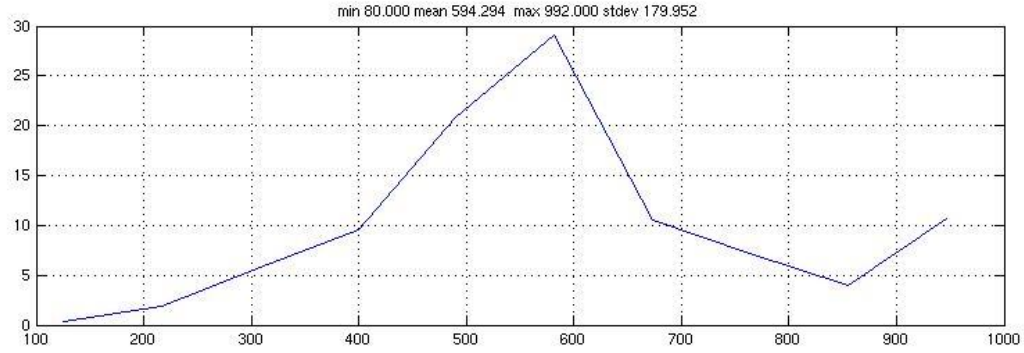

Surface Area Snow Fraction
20
40
60
80
100
120
140
160
180
50
100
150
200
250
300
350
100
80
60
40
20
0

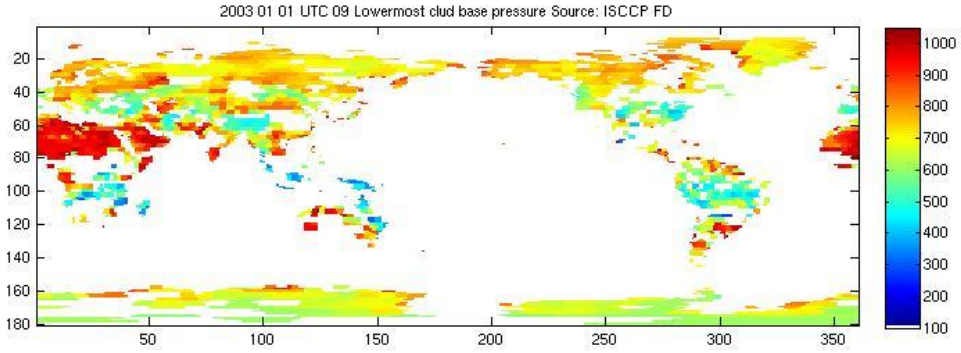

stats excluding 0 min 0.020 mean 0.851 max 1.000 stdev 0.216 pecent=0 54.221
10
8
6
4
2
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

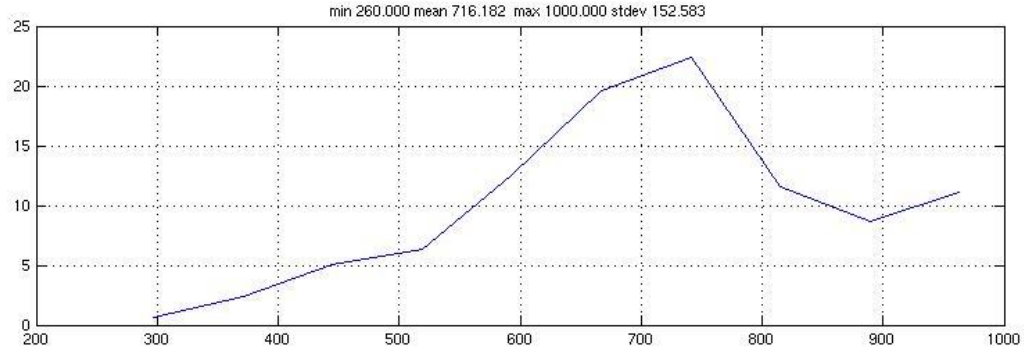

2003 01 01 UTC 09 Total Cloud Fraction Source: ISCCP FD
20
40
60
80
100
120
140
160
180
50
100
150
200
250
300
350
1
0.8
0.6
0.4
0.2
0

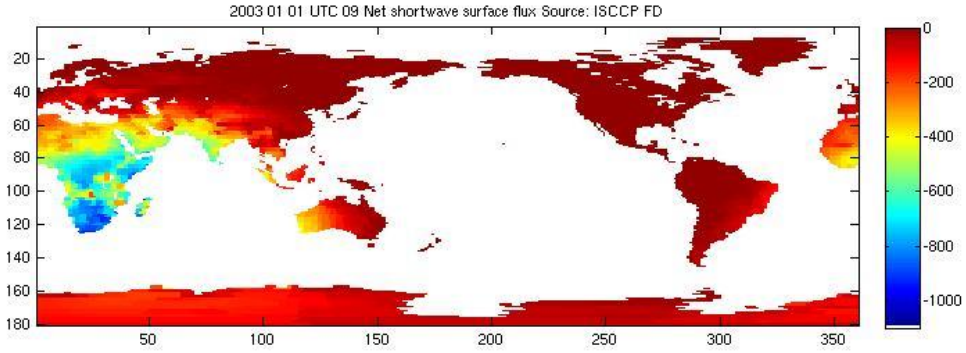

min 0.000 mean 0.578 max 1.000 stdev 0.360
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

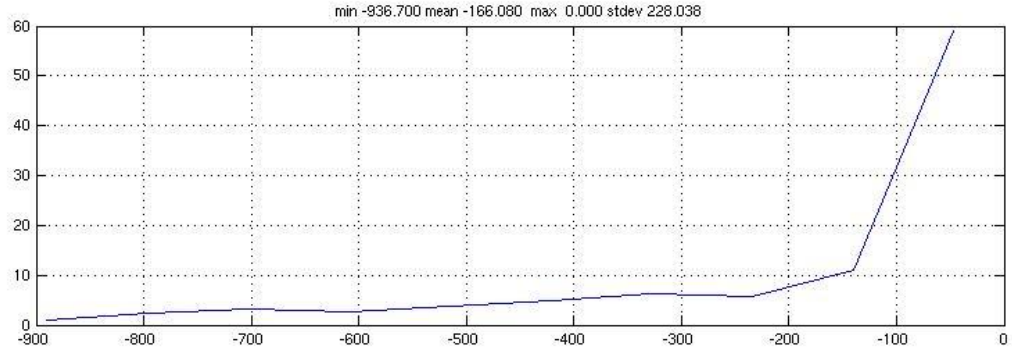

2003 01 01 UTC 09 Uppermost cloud top pressure Source: ISCCP FD
20
40
60
80
100
120
140
160
180
50
100
150
200
250
300
350
1000
900
800
700
600
500
400
300
200
100

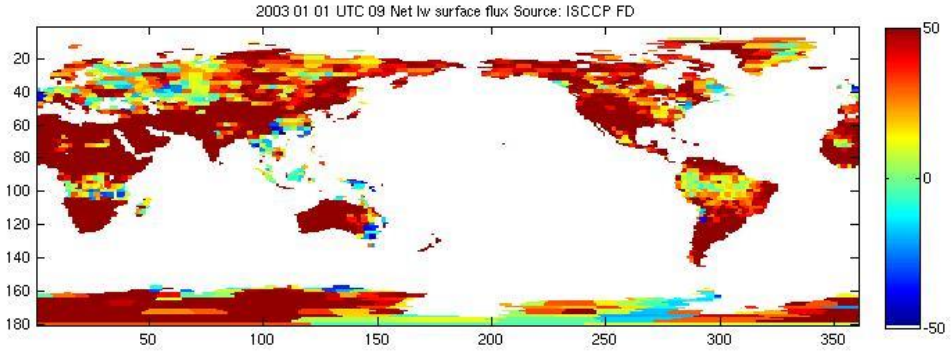

min 80.000 mean 594.294 max 992.000 stdev 179.952
30
25
20
15
10
5
0
100
200
300
400
500
600
700
800
900
1000

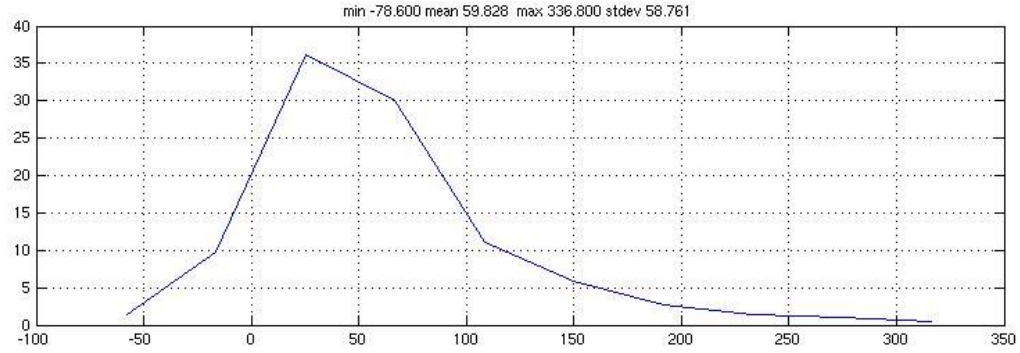

2003 01 01 UTC 09 Lowermost clud base pressure Source: ISCCP FD
20
40
60
80
100
120
140
160
180
50
100
150
200
250
300
350
1000
900
800
700
600
500
400
300
200
100

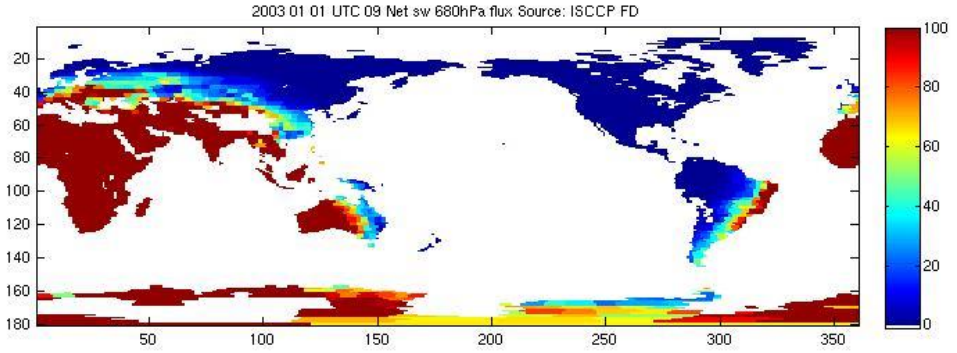

min 260.000 mean 716.182 max 1000.000 stdev 152.583
25
20
15
10
5
0
200
300
400
500
600
700
800
900
1000

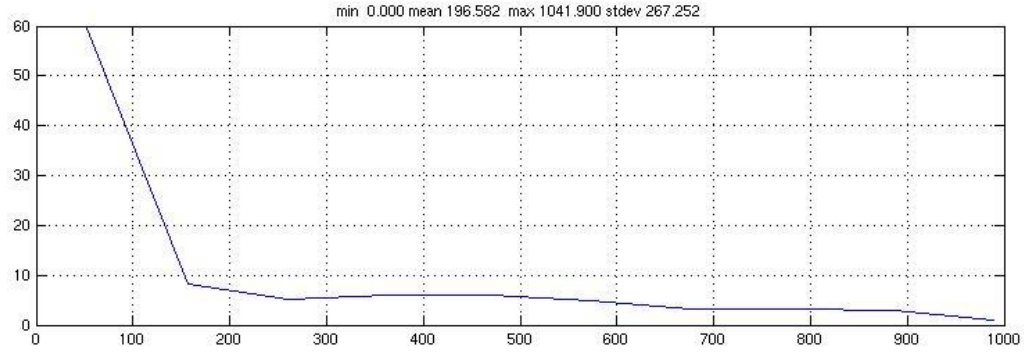

2003 01 01 UTC 09 Net shortwave surface flux Source: ISCCP FD
20
40
60
80
100
120
140
160
180
50
100
150
200
250
300
350
0
-200
-400
-600
-800
-1000

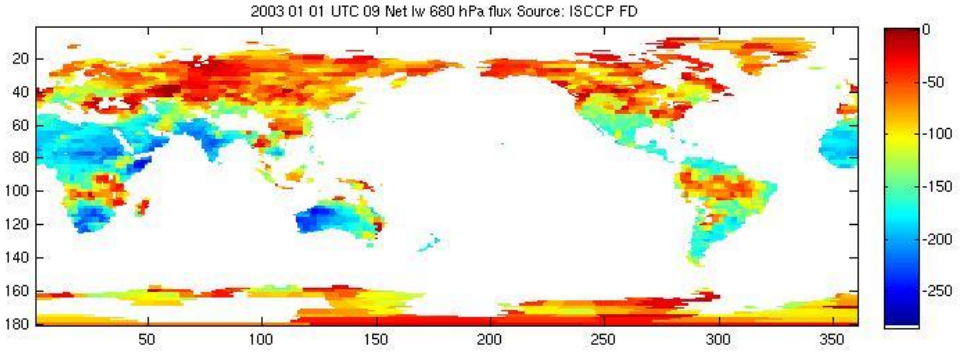

min -936.700 mean -166.080 max 0.000 stdev 228.038
60
50
40
30
20
10
0
-900
-800
-700
-600
-500
-400
-300
-200
-100
0

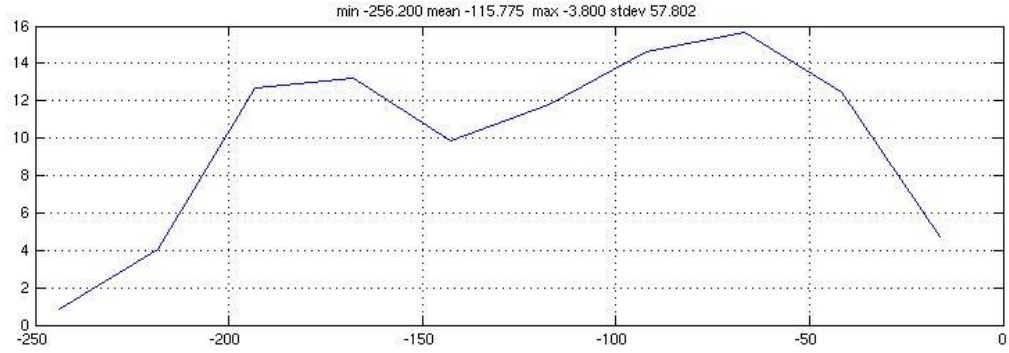

2003 01 01 UTC 09 Net lw surface flux Source: ISCCP FD
20
40
60
80
100
120
140
160
180
50
100
150
200
250
300
350
50
0
-50

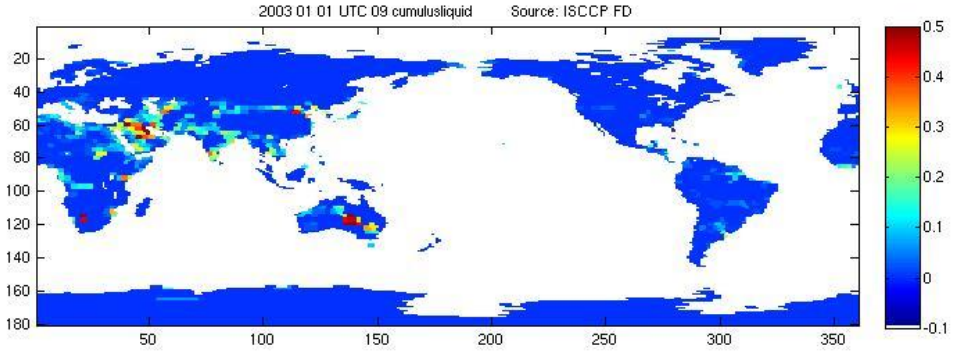

min -78.600 mean 59.828 max 336.800 stdev 58.761
40
35
30
25
20
15
10
5
0
-100
-50
0
50
100
150
200
250
300
350

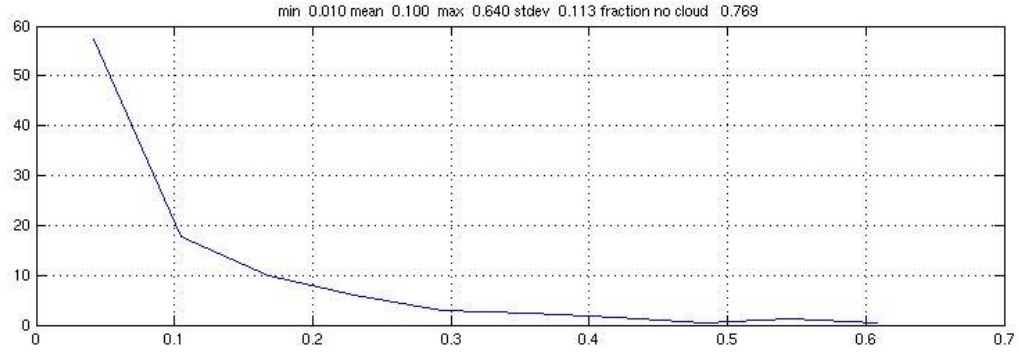

2003 01 01 UTC 09 Net sw 680hPa flux Source: ISCCP FD
20
40
60
80
100
120
140
160
180
50
100
150
200
250
300
350
100
80
60
40
20
0

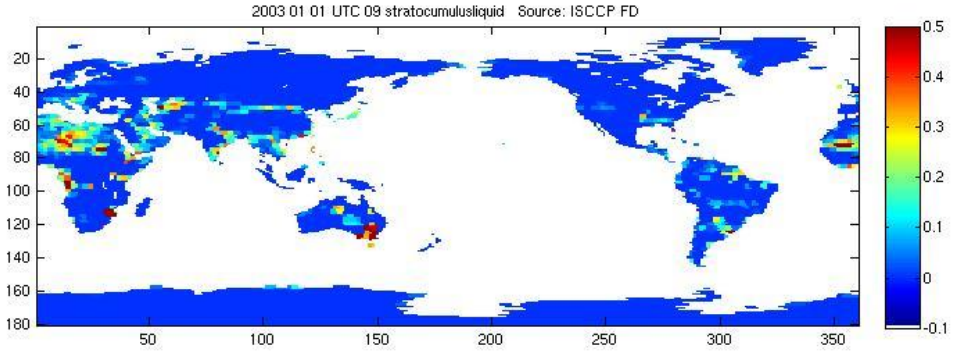

min 0.000 mean 196.582 max 1041.900 stdev 267.252
60
50
40
30
20
10
0
0
100
200
300
400
500
600
700
800
900
1000

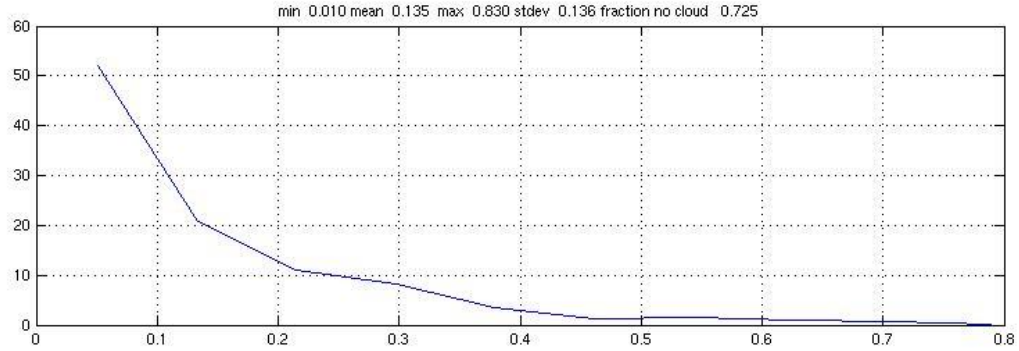

2003 01 01 UTC 09 Net lw 680 hPa flux Source: ISCCP FD
20
40
60
80
100
120
140
160
180
50
100
150
200
250
300
350
0
-50
-100
-150
-200
-250

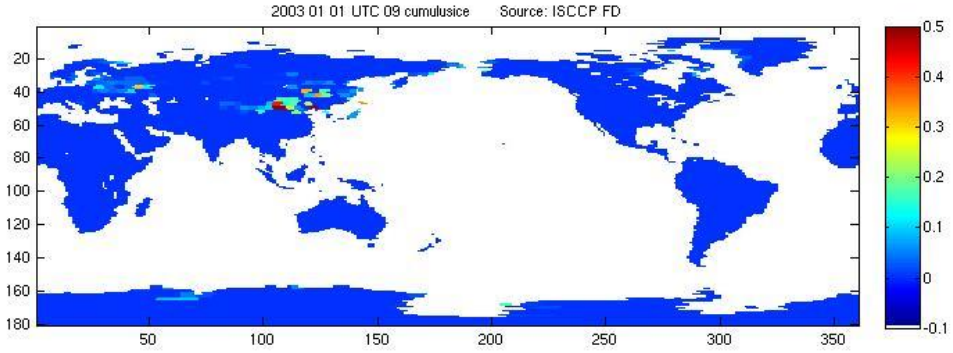

min -256.200 mean -115.775 max -3.800 stdev 57.802
16
14
12
10
8
6
4
2
0
-250
-200
-150
-100
-50
0

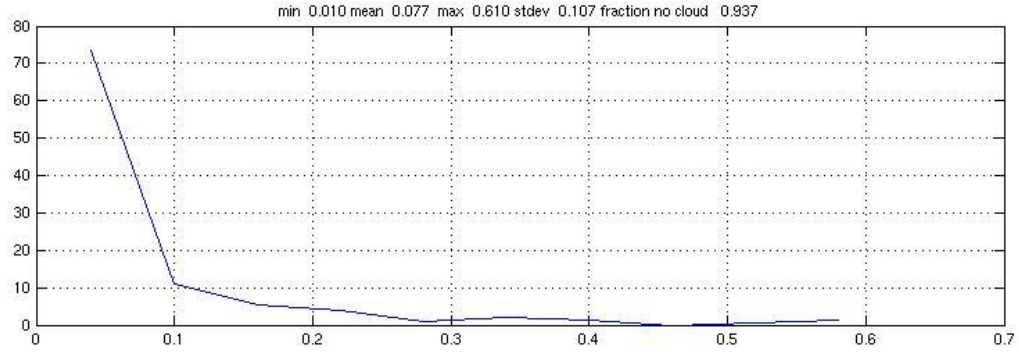

2003 01 01 UTC 09 cumulusliquid
Source: ISCCP FD
20
40
60
80
100
120
140
160
180
50
100
150
200
250
300
350
0.5
0.4
0.3
0.2
0.1
0
-0.1

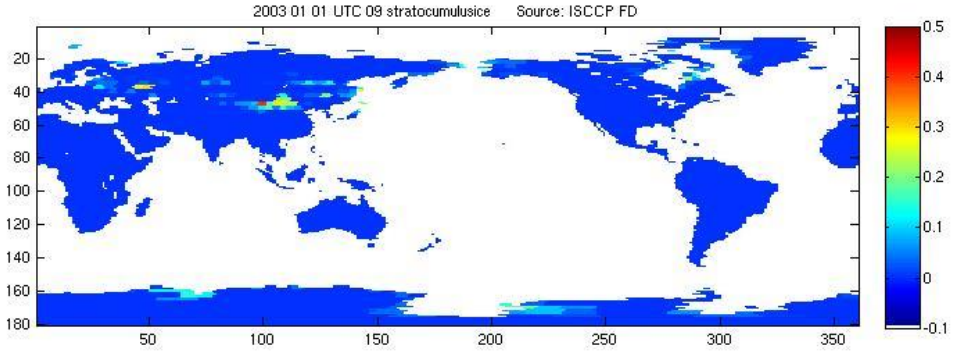

min 0.010 mean 0.100 max 0.640 stdev 0.113 fraction no cloud 0.769
60
50
40
30
20
10
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7

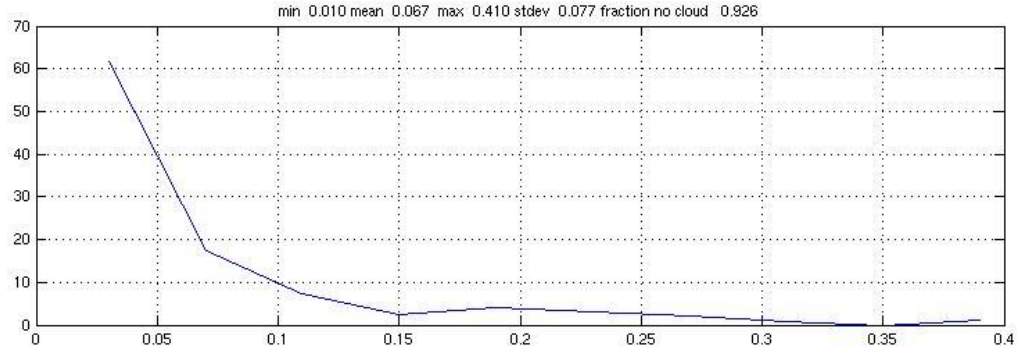

2003 01 01 UTC 09 stratocumulusliquid Source: ISCCP FD
20
40
60
80
100
120
140
160
180
50
100
150
200
250
300
350
0.5
0.4
0.3
0.2
0.1
0
-0.1

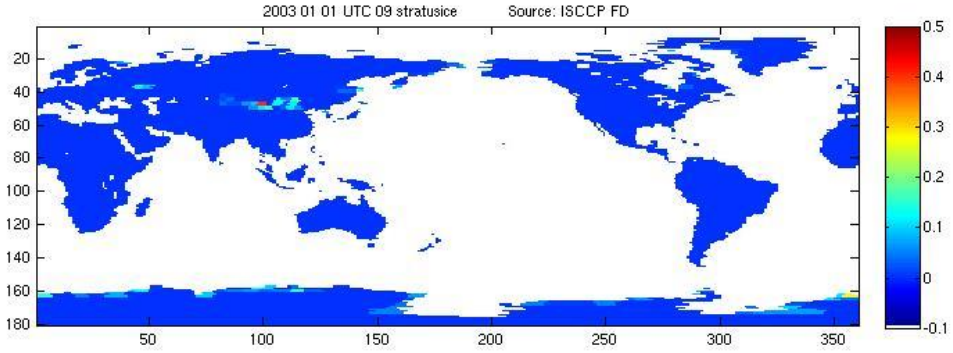

min 0.010 mean 0.135 max 0.830 stdev 0.136 fraction no cloud 0.725
60
50
40
30
20
10
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8

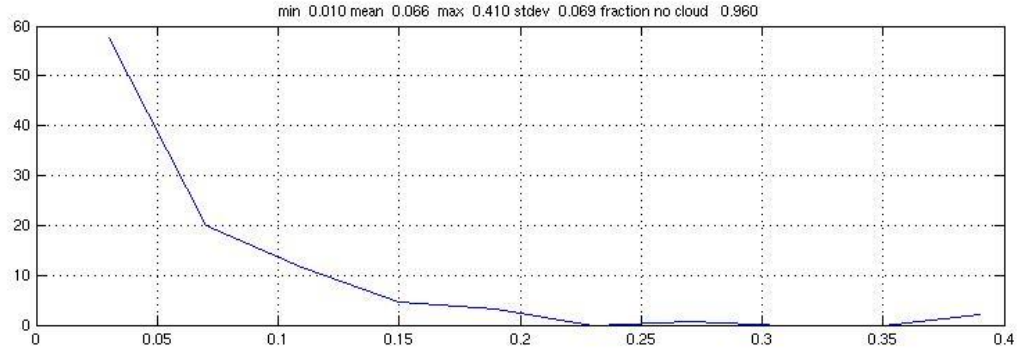

2003 01 01 UTC 09 cumulusice Source: ISCCP FD
20
40
60
80
100
120
140
160
180
50
100
150
200
250
300
350
0.5
0.4
0.3
0.2
0.1
0
-0.1

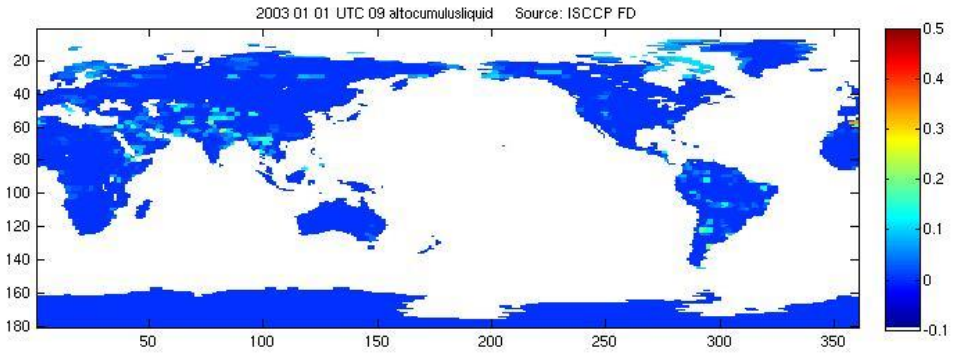

min 0.010 mean 0.077 max 0.610 stdev 0.107 fraction no cloud 0.937
80
70
60
50
40
30
20
10
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7

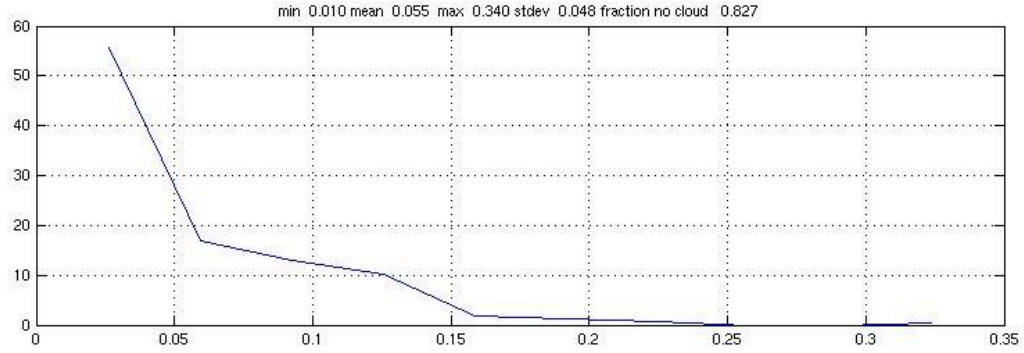

2003 01 01 UTC 09 stratocumulusice Source: ISCCP FD
20
40
60
80
100
120
140
160
180
50
100
150
200
250
300
350
0.5
0.4
0.3
0.2
0.1
0
-0.1

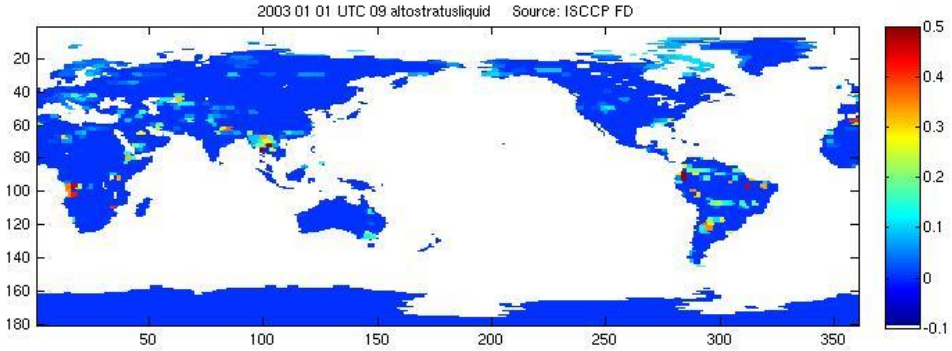

min 0.010 mean 0.067 max 0.410 stdev 0.077 fraction no cloud 0.926
70
60
50
40
30
20
10
0
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4


2003 01 01 UTC 09 stratusice
Source: ISCCP FD
20
40
60
80
100
120
140
160
180
50
100
150
200
250
300
350
0.5
0.4
0.3
0.2
0.1
0
-0.1


min 0.010 mean 0.066 max 0.410 stdev 0.069 fraction no cloud 0.960
60
50
40
30
20
10
0
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4


2003 01 01 UTC 09 altocumulusliquid Source: ISCCP FD
20
40
60
80
100
120
140
160
180
50
100
150
200
250
300
350
0.5
0.4
0.3
0.2
0.1
0
-0.1


min 0.010 mean 0.055 max 0.340 stdev 0.048 fraction no cloud 0.827
60
50
40
30
20
10
0
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35


2003 01 01 UTC 09 altostratusliquid Source: ISCCP FD
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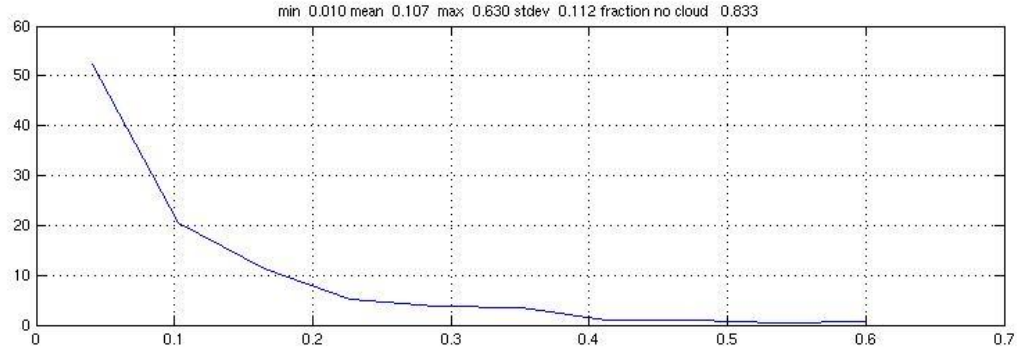
min 0.010 mean 0.107 max 0.630 stdev 0.112 fraction no cloud 0.833
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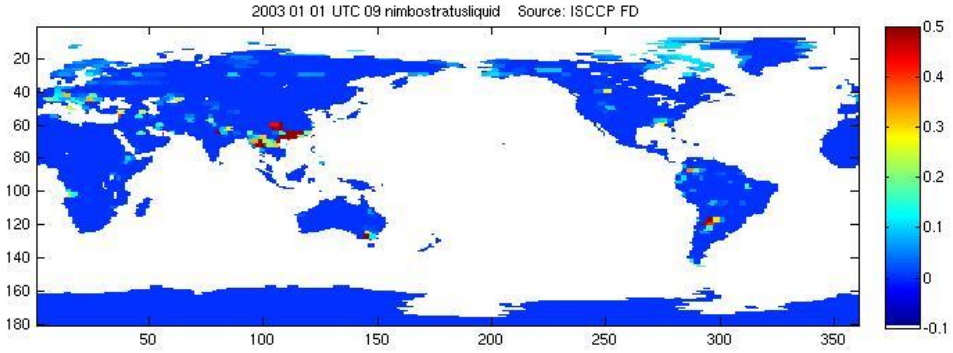
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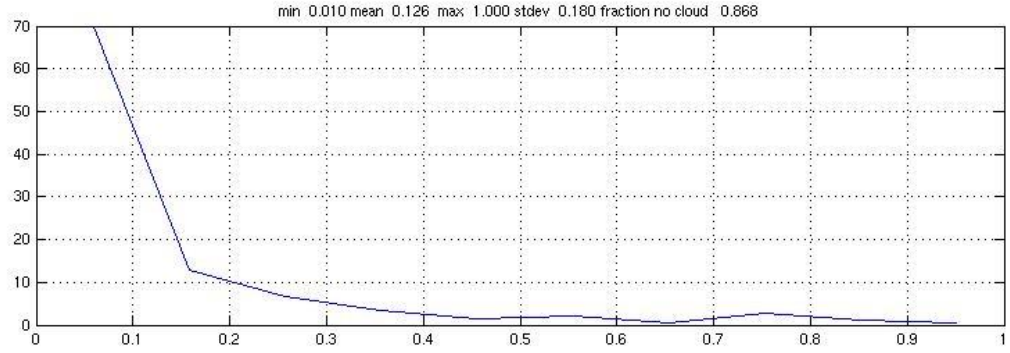
min 0.010 mean 0.126 max 1.000 stdev 0.180 fraction no cloud 0.868
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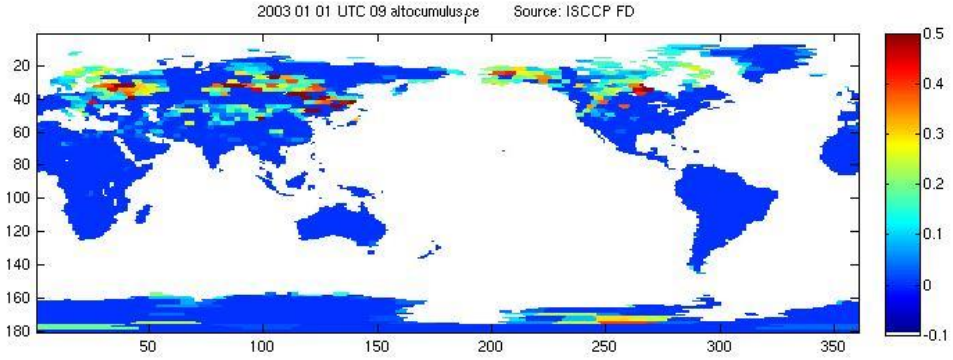
2003 01 01 UTC 09 altocumulus ce
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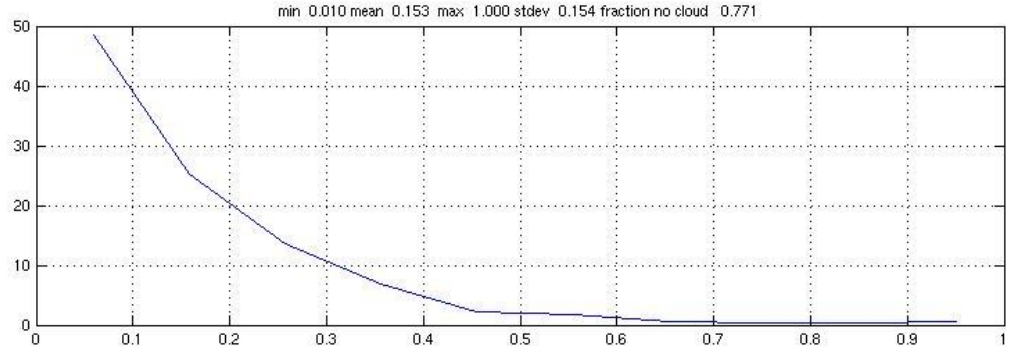
min 0.010 mean 0.153 max 1.000 stdev 0.154 fraction no cloud 0.771
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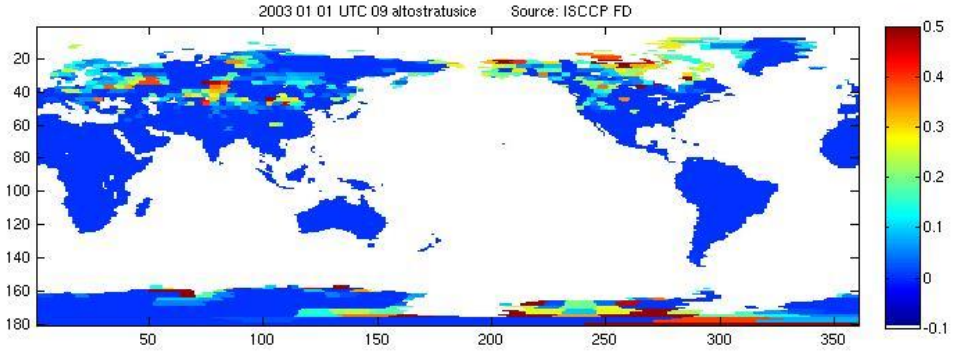
2003 01 01 UTC 09 altostratusice
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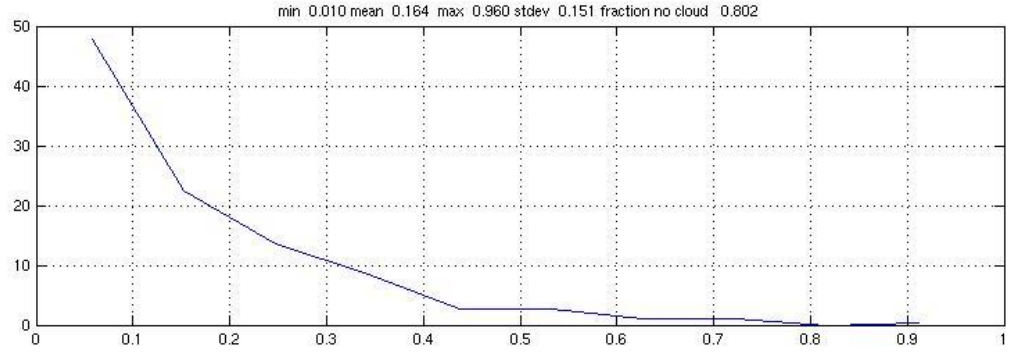
min 0.010 mean 0.164 max 0.960 stdev 0.151 fraction no cloud 0.802
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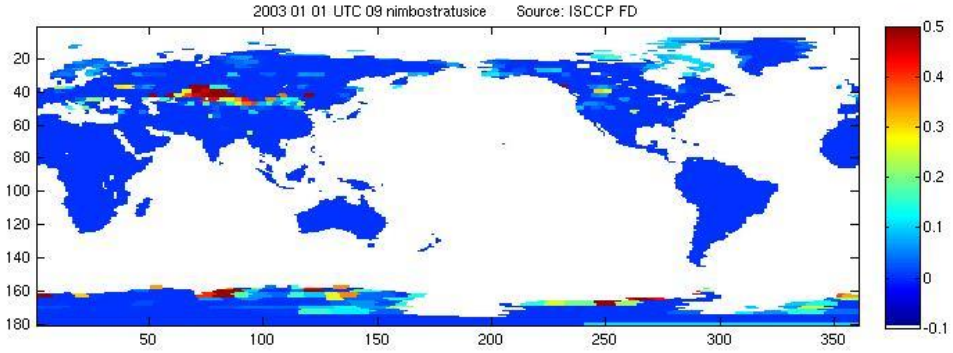
2003 01 01 UTC 09 nimbostratusice
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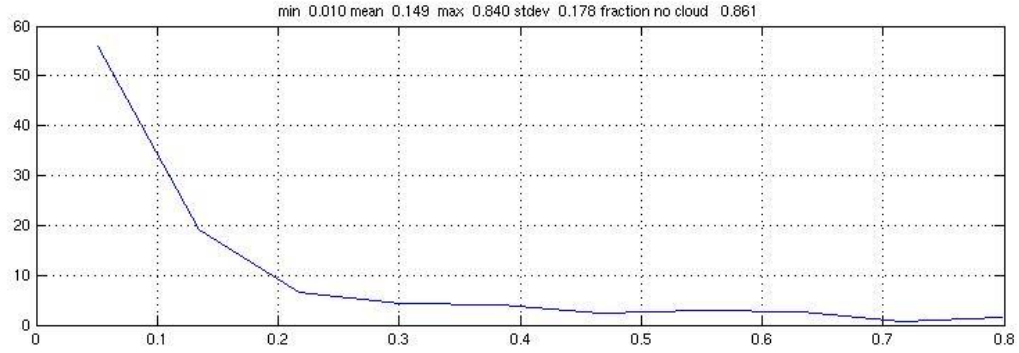
min 0.010 mean 0.149 max 0.840 stdev 0.178 fraction no cloud 0.861
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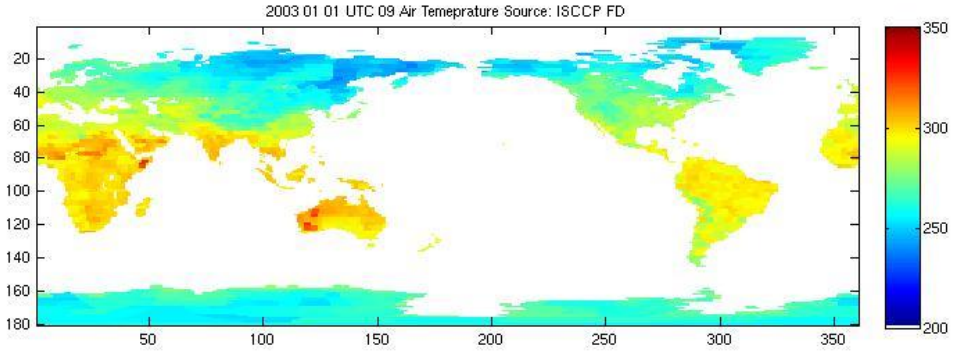
2003 01 01 UTC 09 Air Temeprature Source: ISCCP FD
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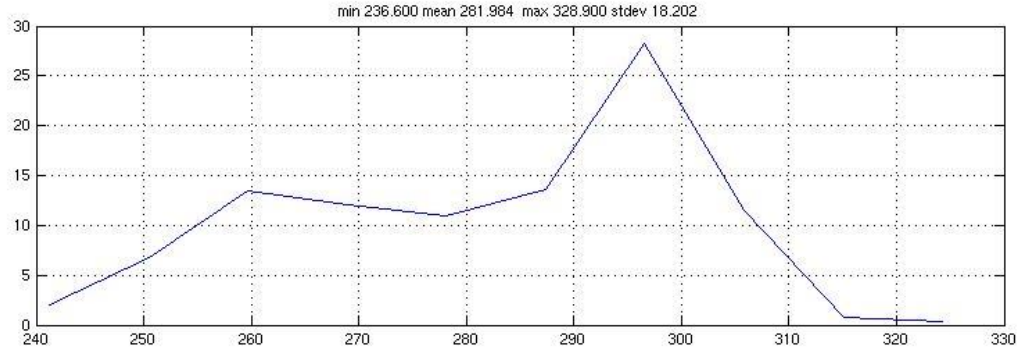
min 236.600 mean 281.984 max 328.900 stdev 18.202
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320
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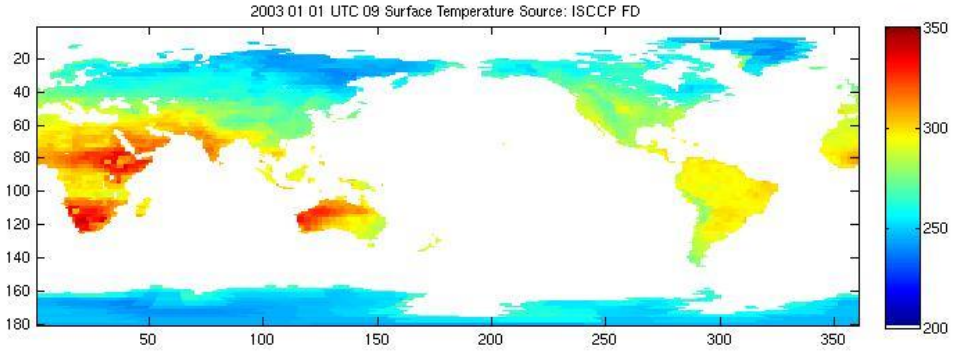
2003 01 01 UTC 09 Surface Temperature Source: ISCCP FD
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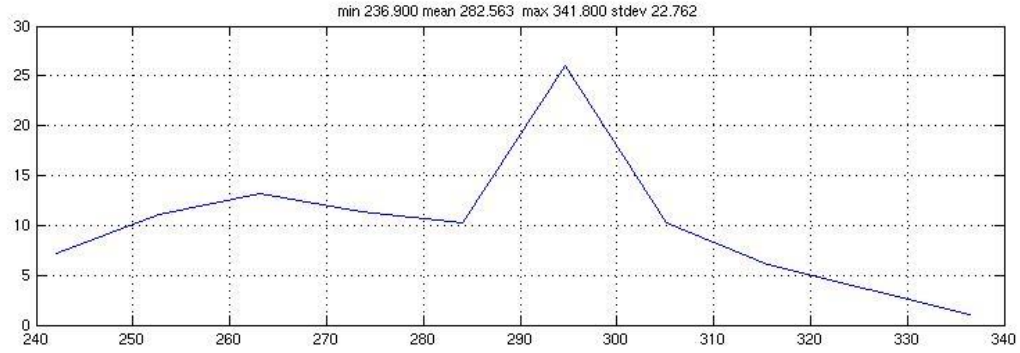
min 236.900 mean 282.563 max 341.800 stdev 22.762
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330
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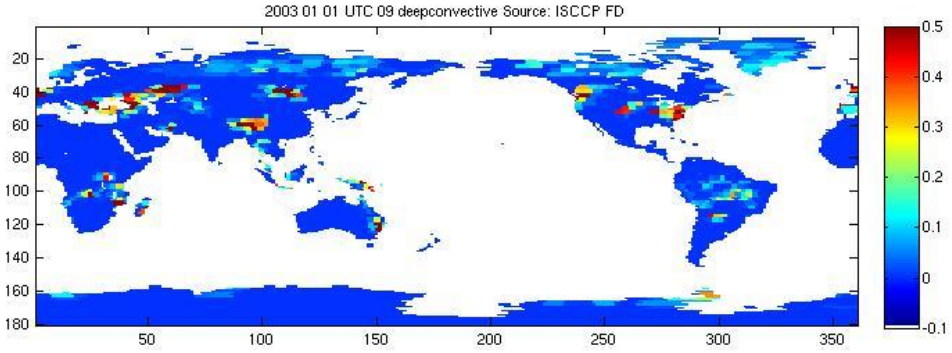
2003 01 01 UTC 09 deepconvective Source: ISCCP FD
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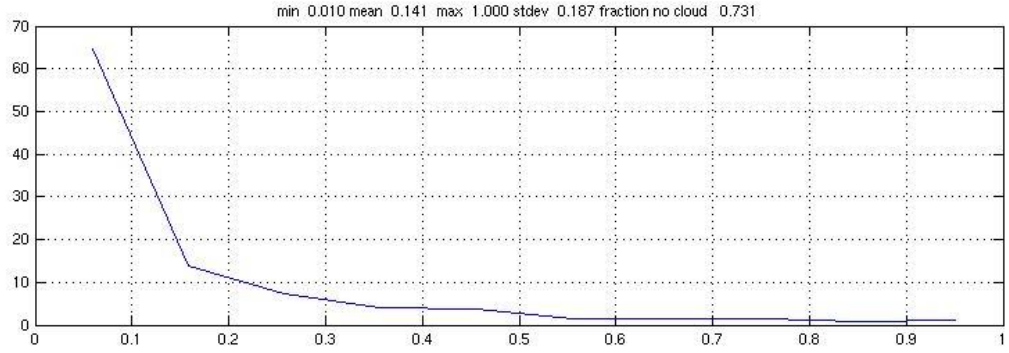
min 0.010 mean 0.141 max 1.000 stdev 0.187 fraction no cloud 0.731
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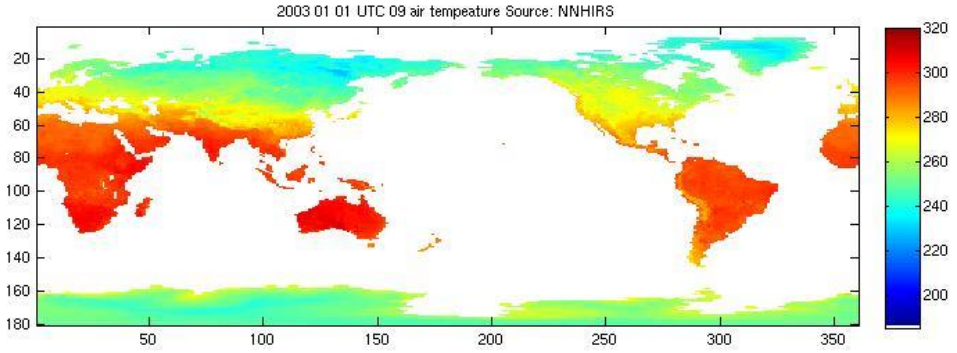
2003 01 01 UTC 09 air tempeature Source: NNHIRS
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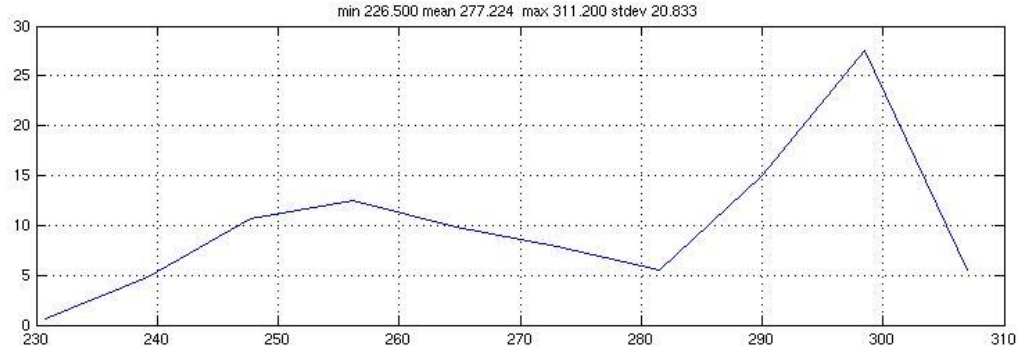
min 226.500 mean 277.224 max 311.200 stdev 20.833
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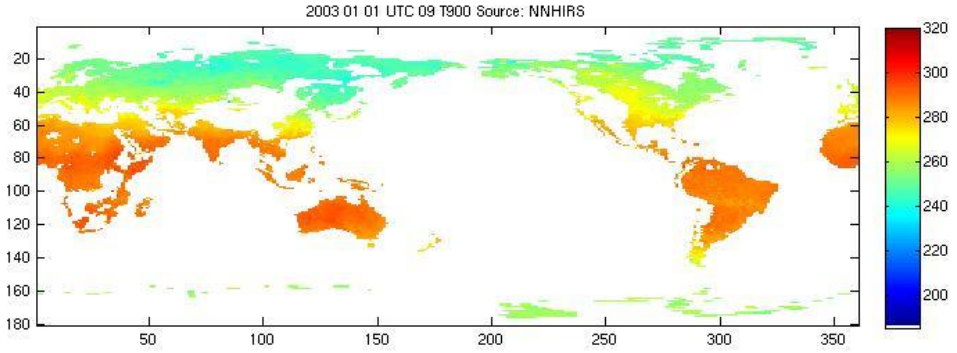
2003 01 01 UTC 09 T900 Source: NNHIRS
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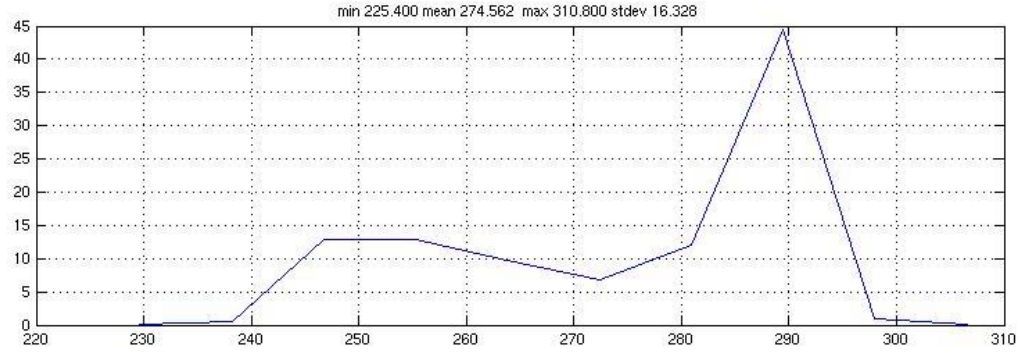
min 225.400 mean 274.562 max 310.800 stdev 16.328
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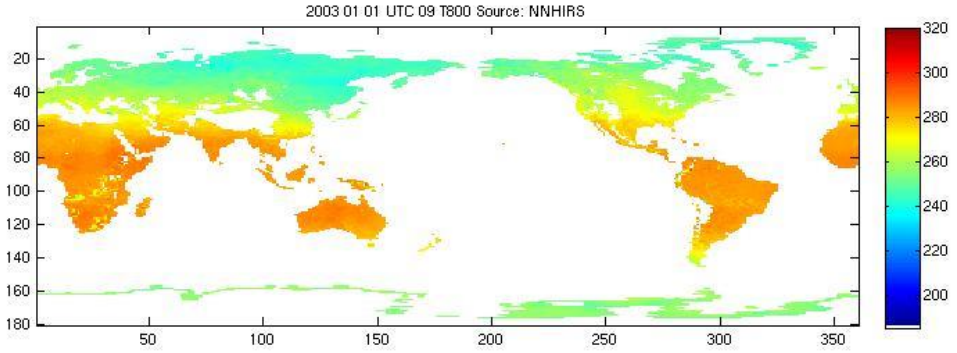
2003 01 01 UTC 09 T800 Source: NNHIRS
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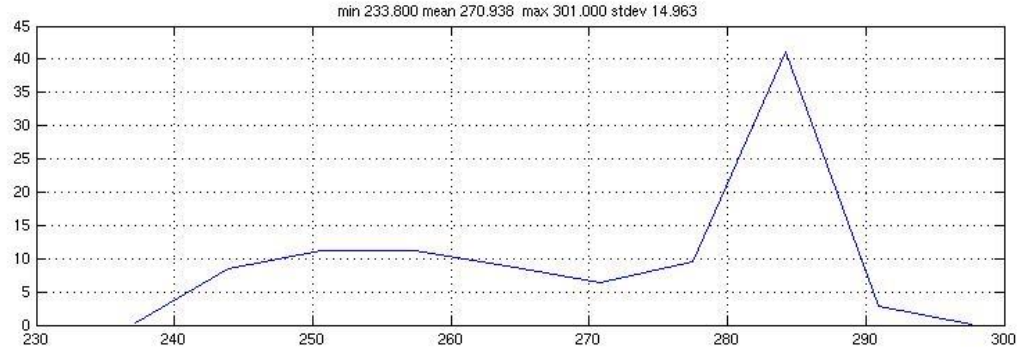
min 233.800 mean 270.938 max 301.000 stdev 14.863
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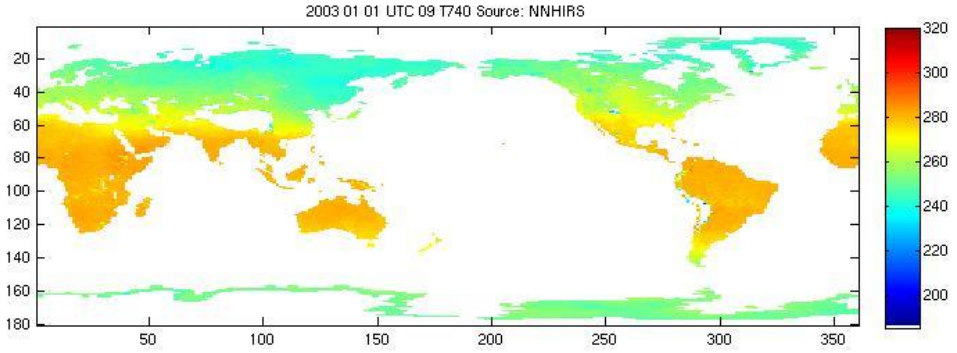
290
300


2003 01 01 UTC 09 T740 Source: NNHIRS
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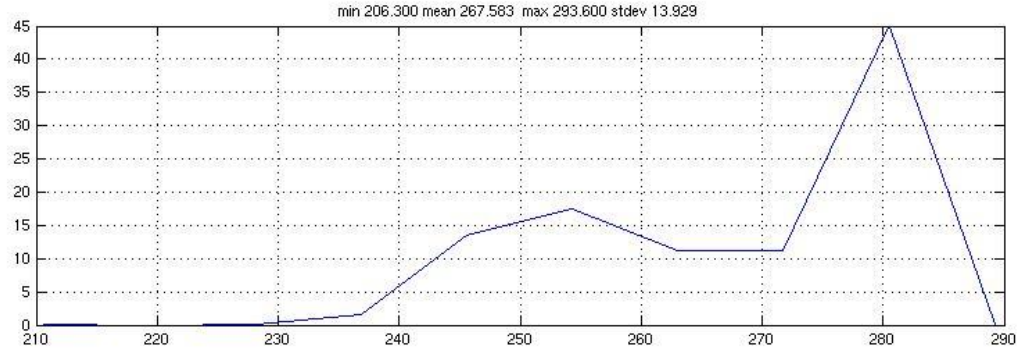
min 206.300 mean 267.583 max 293.600 stdev 13.929
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280
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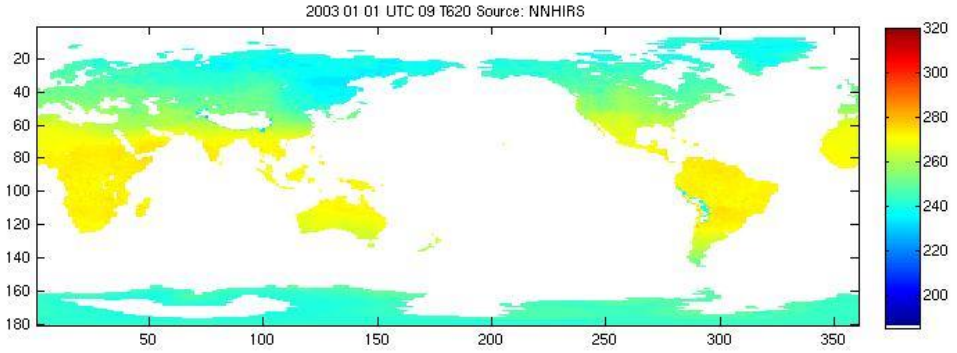
2003 01 01 UTC 09 T620 Source: NNHIRS
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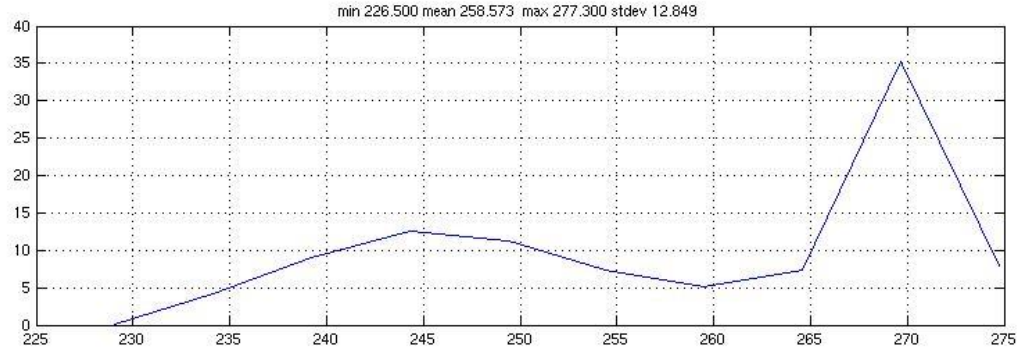
min 226.500 mean 258.573 max 277.300 stdev 12.849
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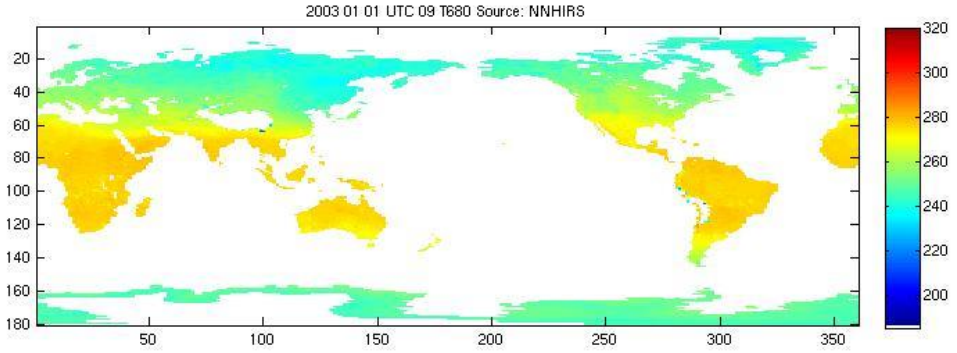
270
275


2003 01 01 UTC 09 T680 Source: NNHIRS
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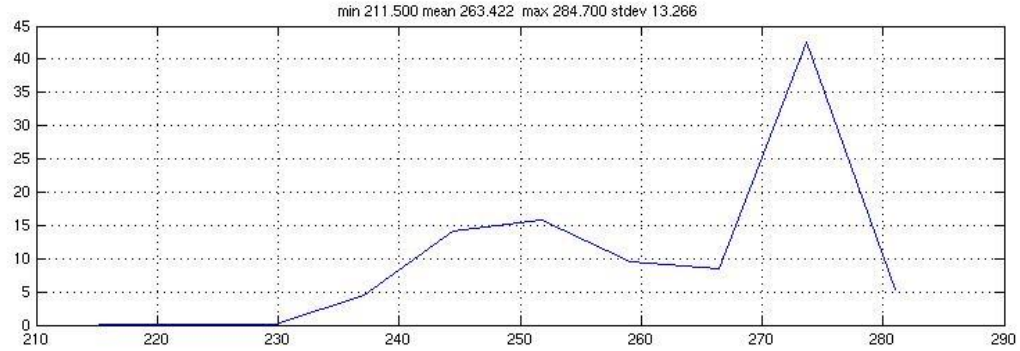
min 211.500 mean 263.422 max 284.700 stdev 13.266
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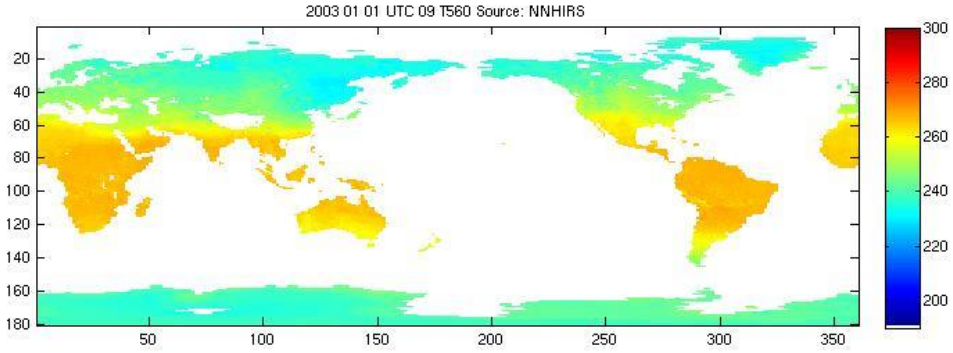
2003 01 01 UTC 09 T560 Source: NNHIRS
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220
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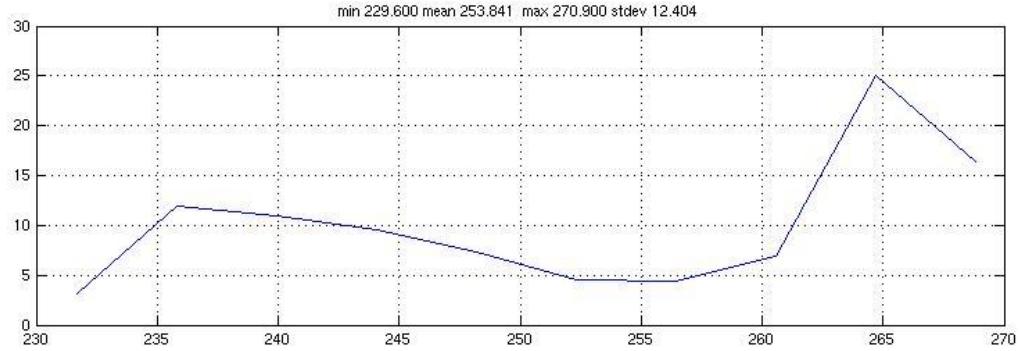
min 229.600 mean 253.841 max 270.900 stdev 12.404
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255
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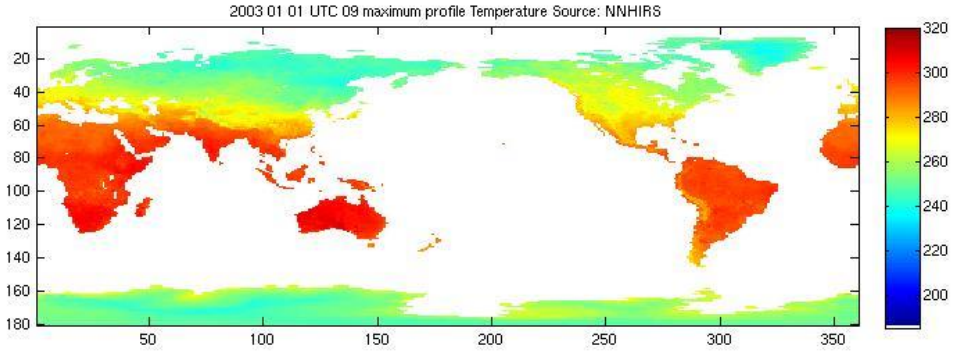
265
270


2003 01 01 UTC 09 maximum profile Temperature Source: NNHIRS
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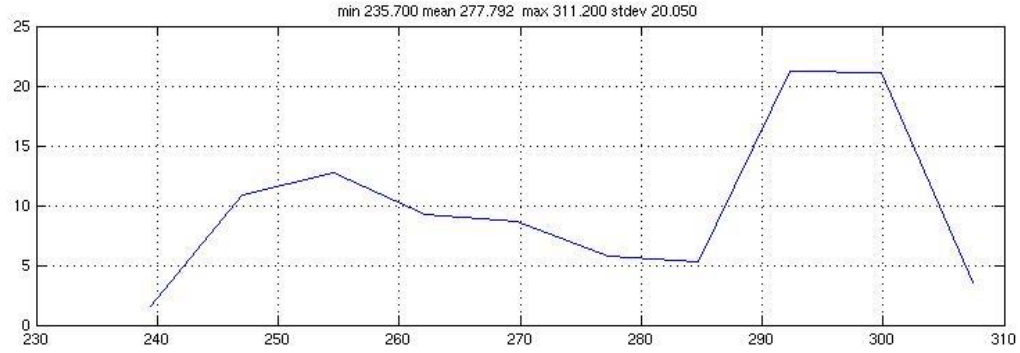
min 235.700 mean 277.792 max 311.200 stdev 20.050
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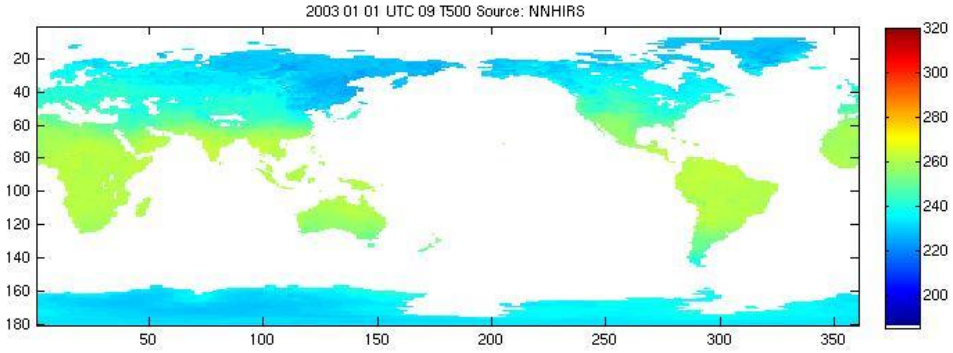
2003 01 01 UTC 09 T500 Source: NNHIRS
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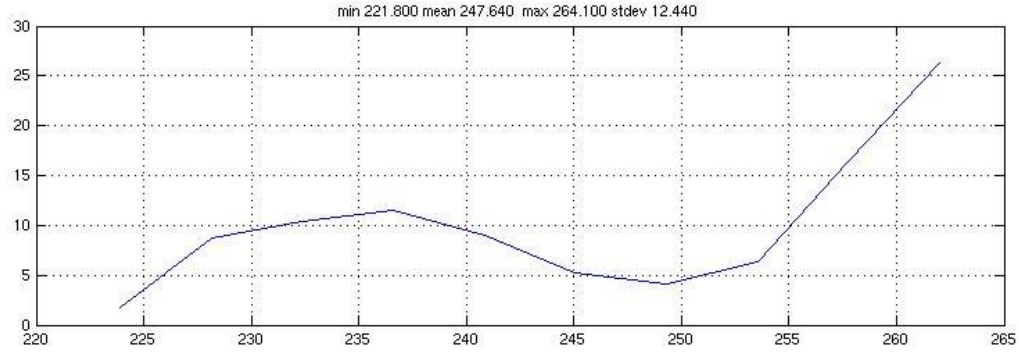
min 221.800 mean 247.640 max 264.100 stdev 12.440
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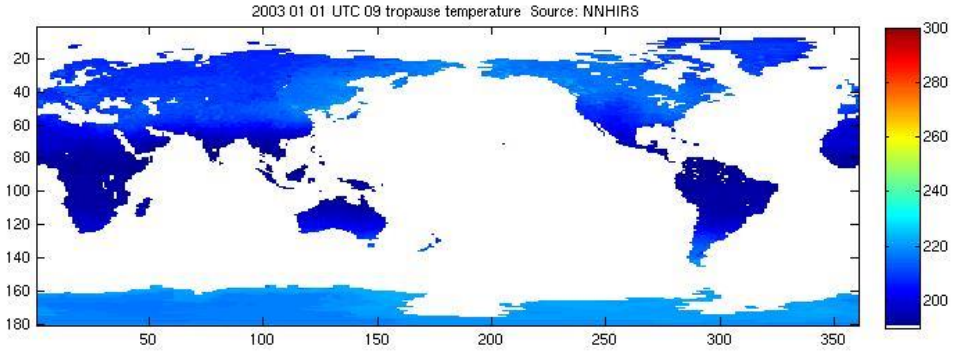
2003 01 01 UTC 09 tropause temperature Source: NNHIRS
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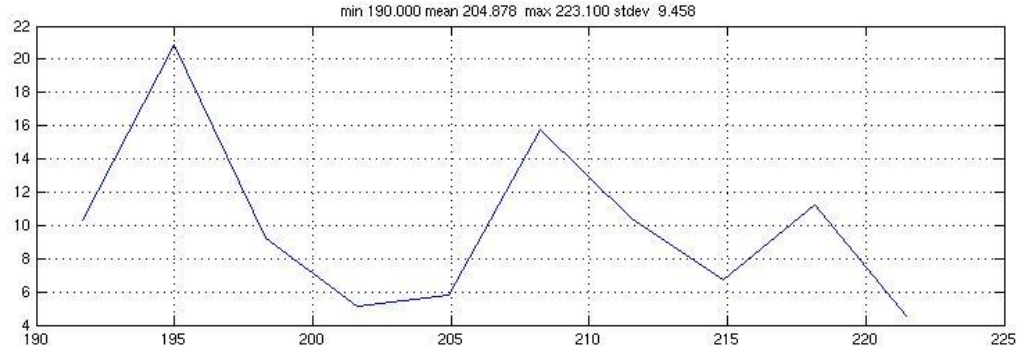
min 190.000 mean 204.878 max 223.100 stdev 9.458
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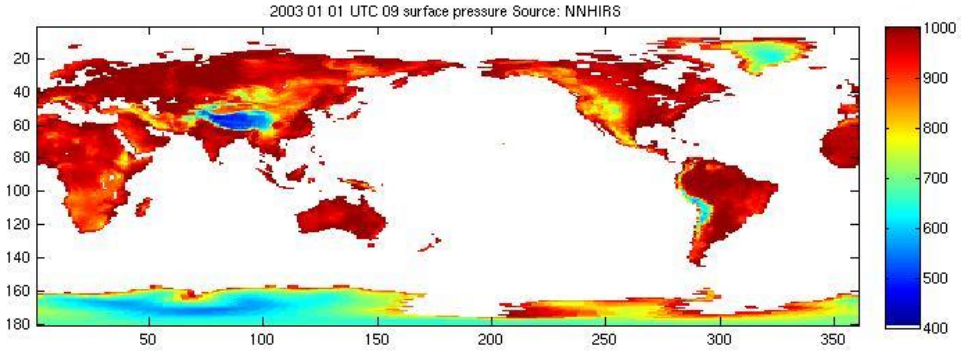
225


2003 01 01 UTC 09 surface pressure Source: NNHIRS
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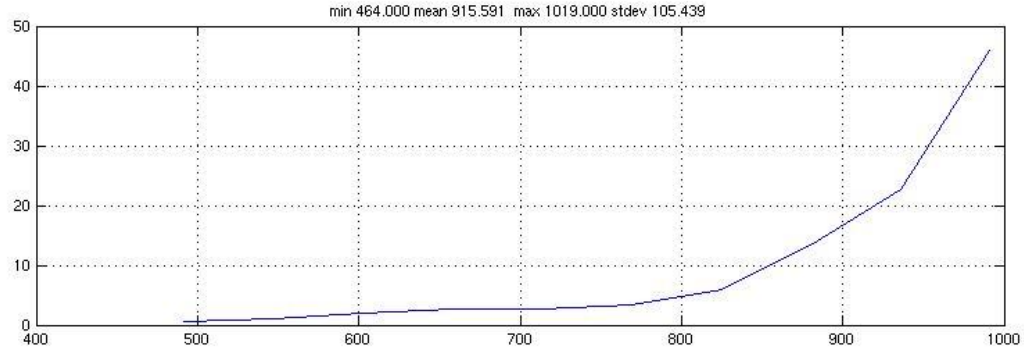
min 464.000 mean 915.591 max 1019.000 stdev 105.439
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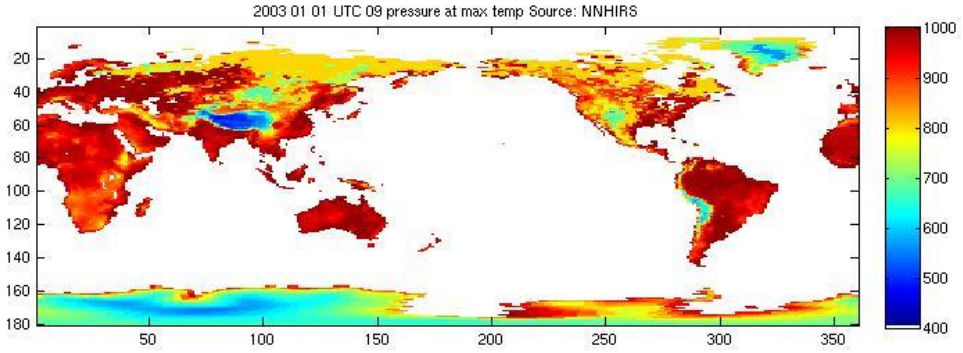
2003 01 01 UTC 09 pressure at max temp Source: NNHIRS
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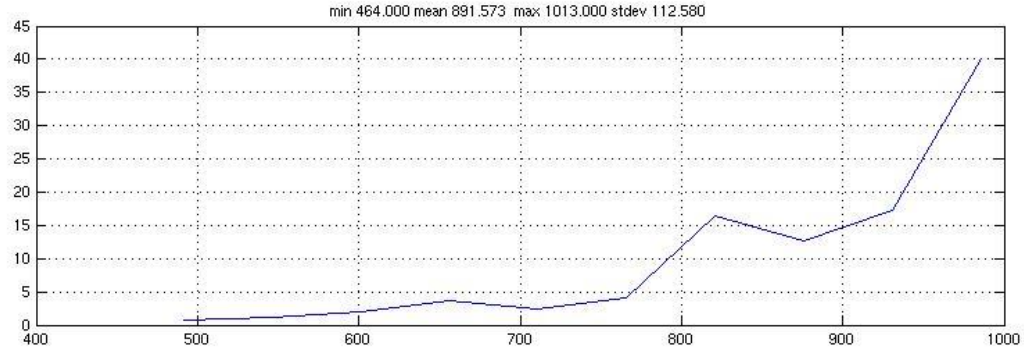
min 464.000 mean 891.573 max 1013.000 stdev 112.580
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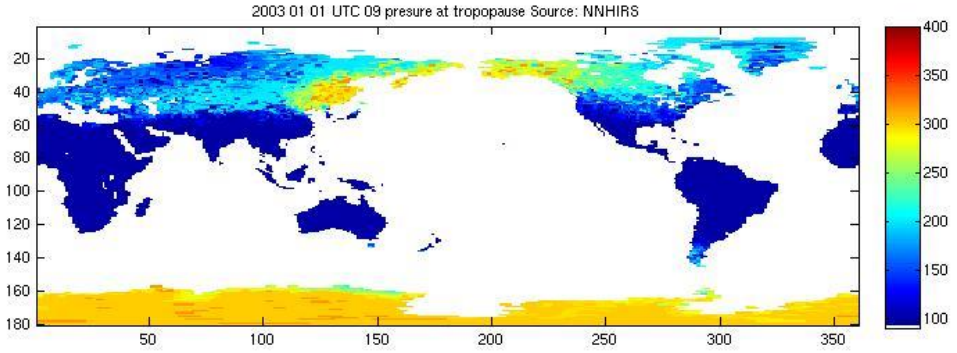
2003 01 01 UTC 09 presure at tropopause Source: NNHIRS
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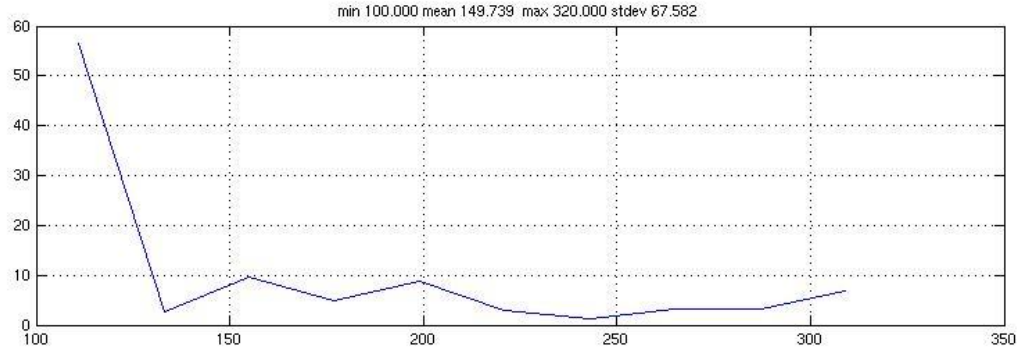
min 100.000 mean 149.739 max 320.000 stdev 67.582
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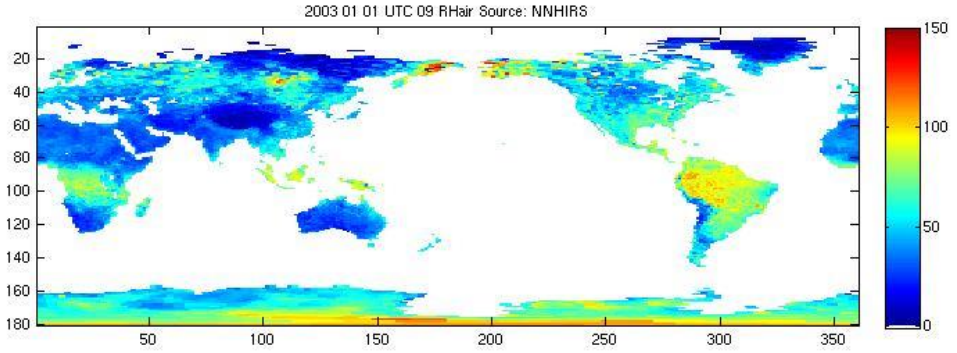
2003 01 01 UTC 09 RHair Source: NNHIRS
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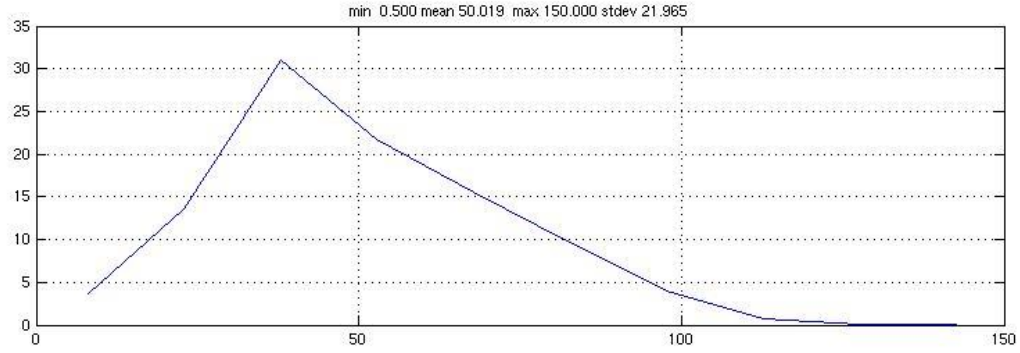
min 0.500 mean 50.019 max 150.000 stdev 21.965
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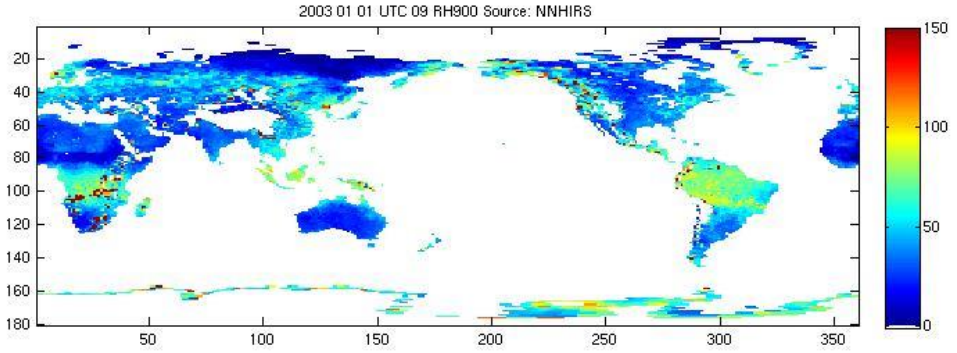
2003 01 01 UTC 09 RH900 Source: NNHIRS
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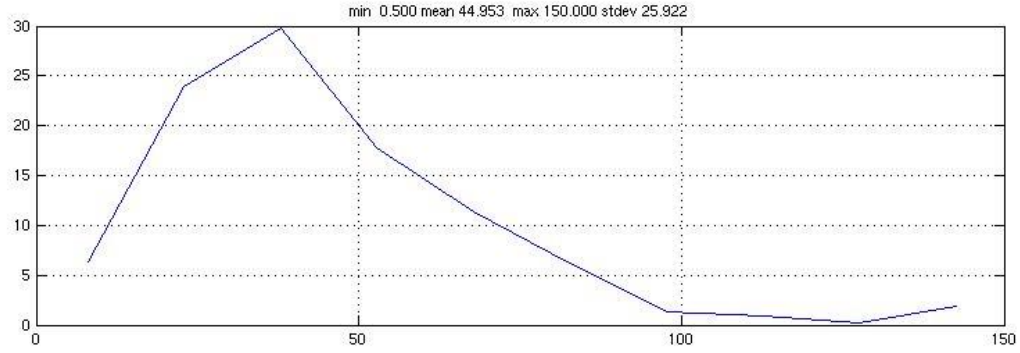
min 0.500 mean 44.953 max 150.000 stdev 25.922
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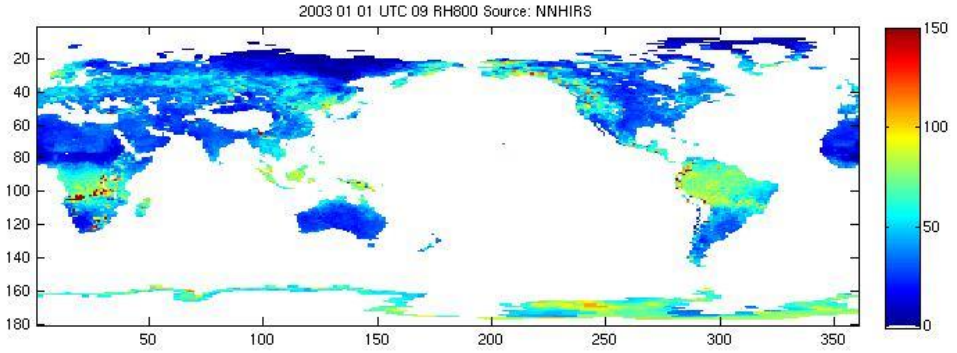
2003 01 01 UTC 09 RH800 Source: NNHIRS
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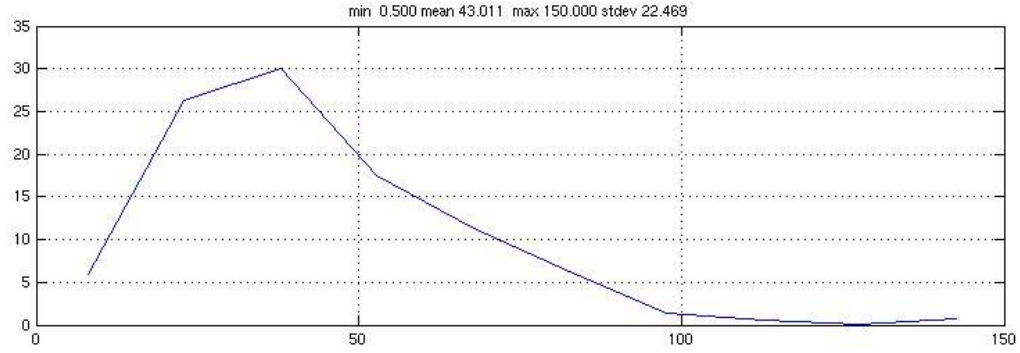
min 0.500 mean 43.011 max 150.000 stdev 22.469
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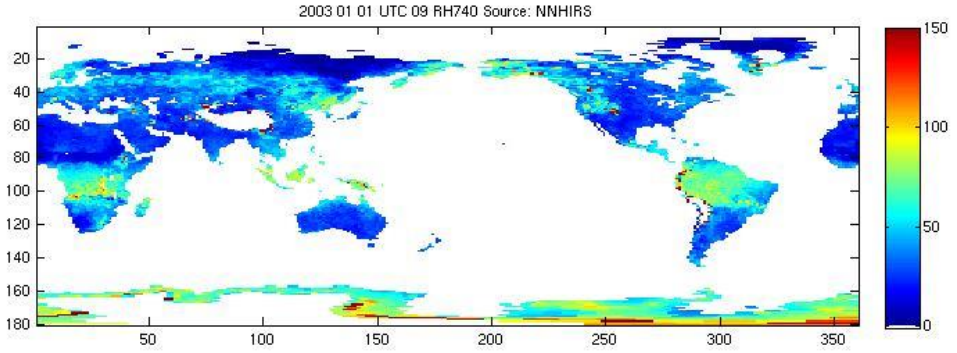
2003 01 01 UTC 09 RH740 Source: NNHIRS
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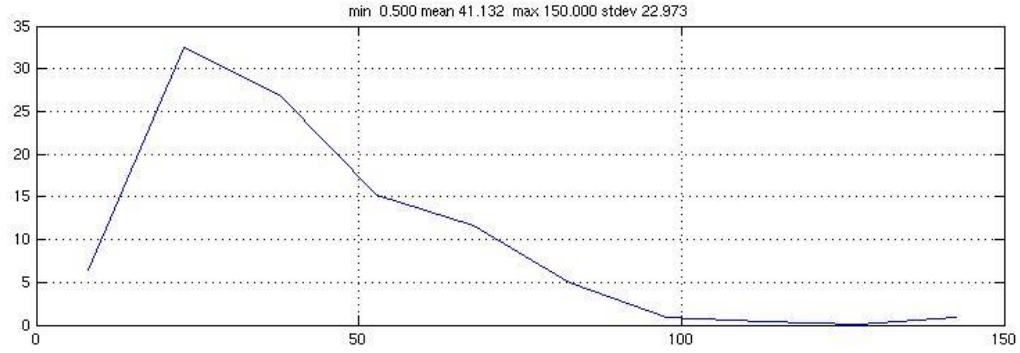
min 0.500 mean 41.132 max 150.000 stdev 22.973
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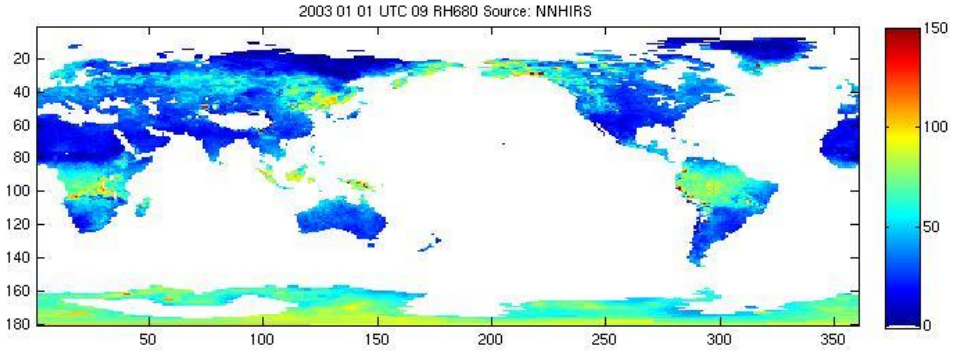
2003 01 01 UTC 09 RH680 Source: NNHIRS
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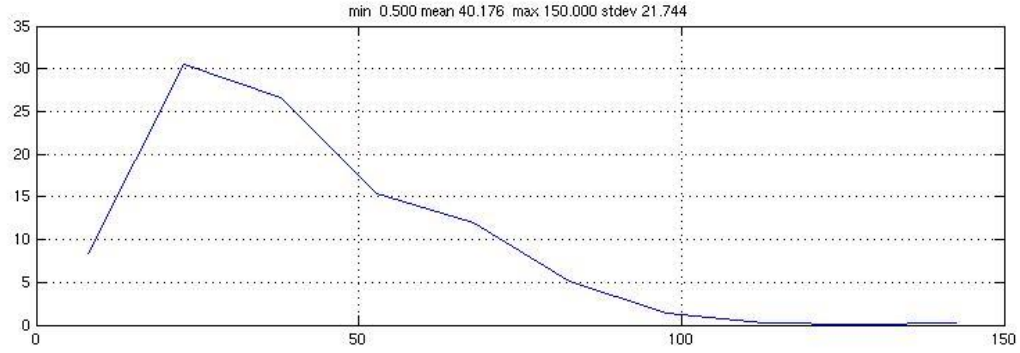
min 0.500 mean 40.176 max 150.000 stdev 21.744
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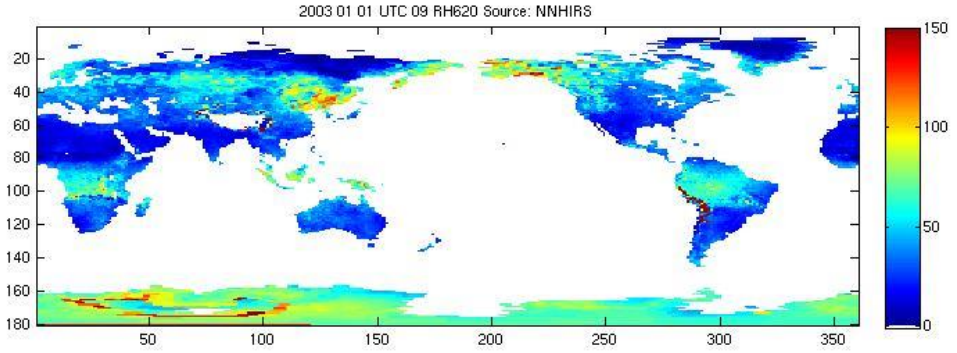
2003 01 01 UTC 09 RH620 Source: NNHIRS
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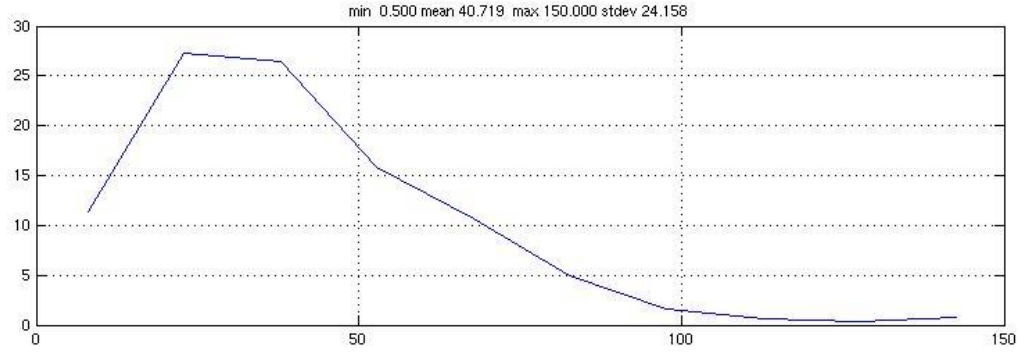
min 0.500 mean 40.719 max 150.000 stdev 24.158
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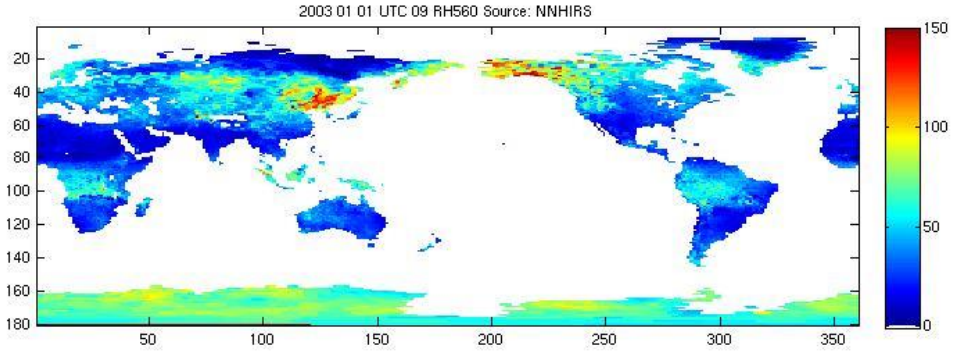
2003 01 01 UTC 09 RH560 Source: NNHIRS
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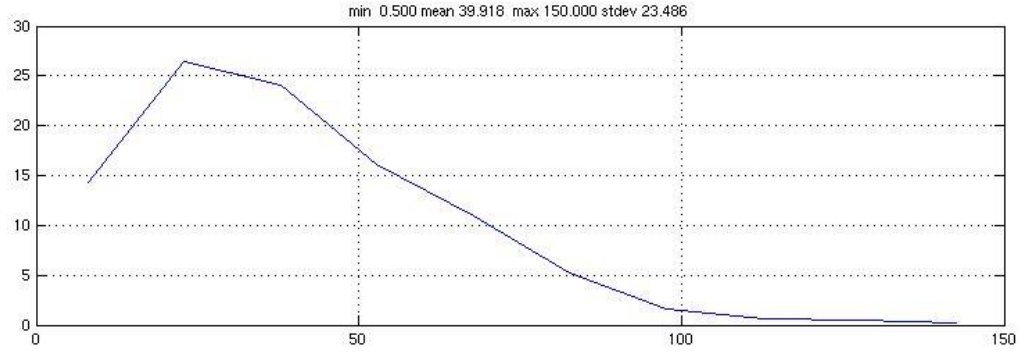
min 0.500 mean 39.918 max 150.000 stdev 23.486
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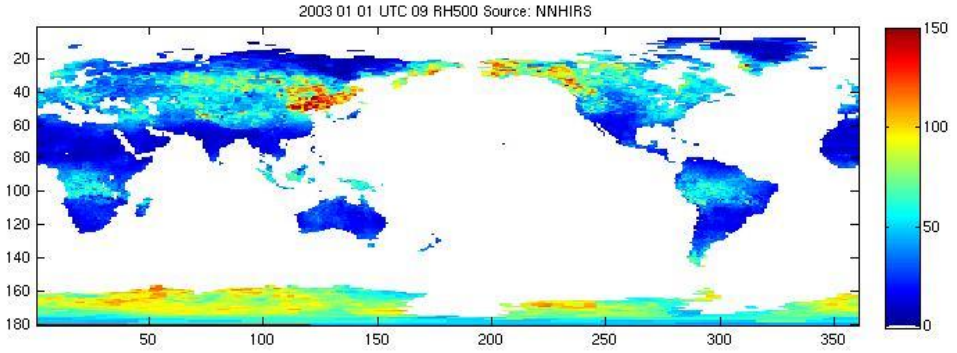
2003 01 01 UTC 09 RH500 Source: NNHIRS
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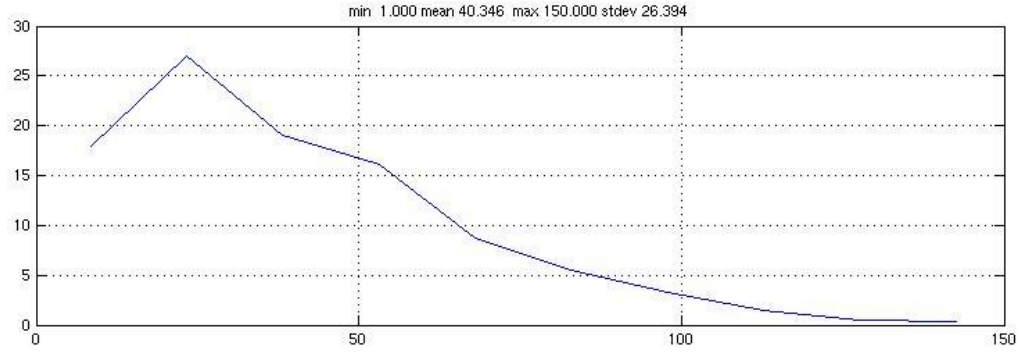
min 1.000 mean 40.346 max 150.000 stdev 26.394
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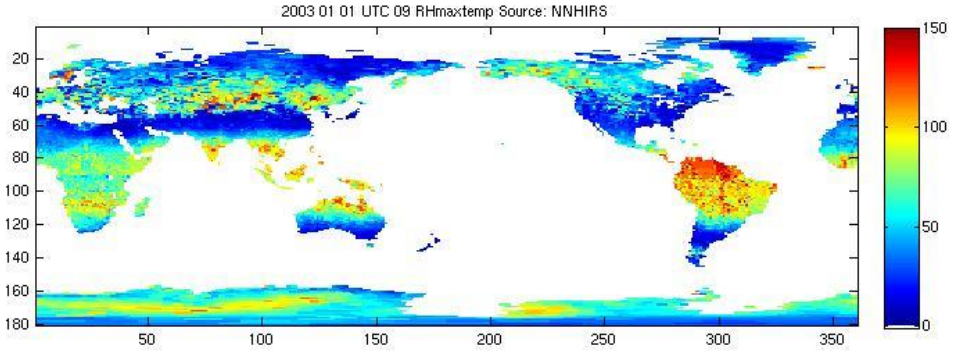
2003 01 01 UTC 09 RHmaxtemp Source: NNHIRS
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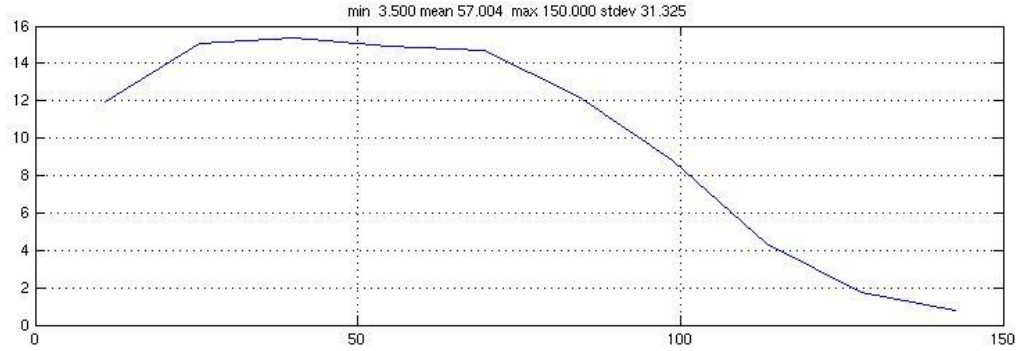
min 3.500 mean 57.004 max 150.000 stdev 31.325
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14
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8
6
4
2
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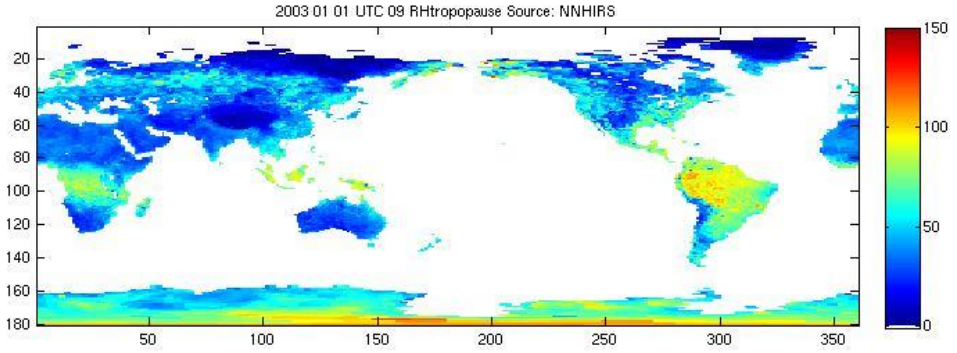
2003 01 01 UTC 09 RHtropopause Source: NNHIRS
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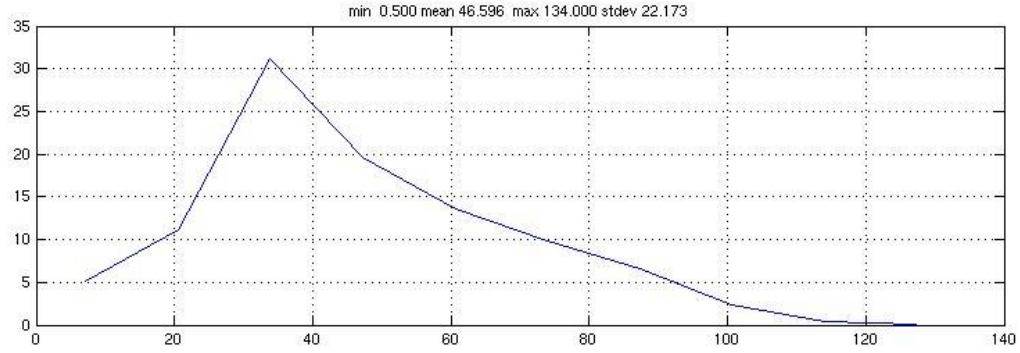
min 0.500 mean 46.596 max 134.000 stdev 22.173
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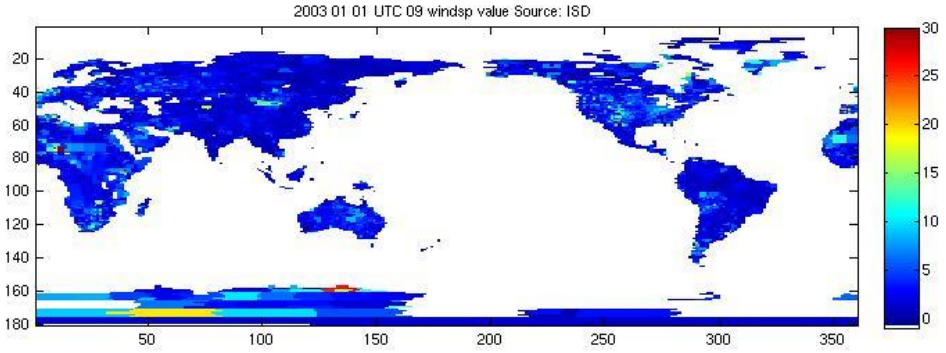
2003 01 01 UTC 09 windsp value Source: ISD
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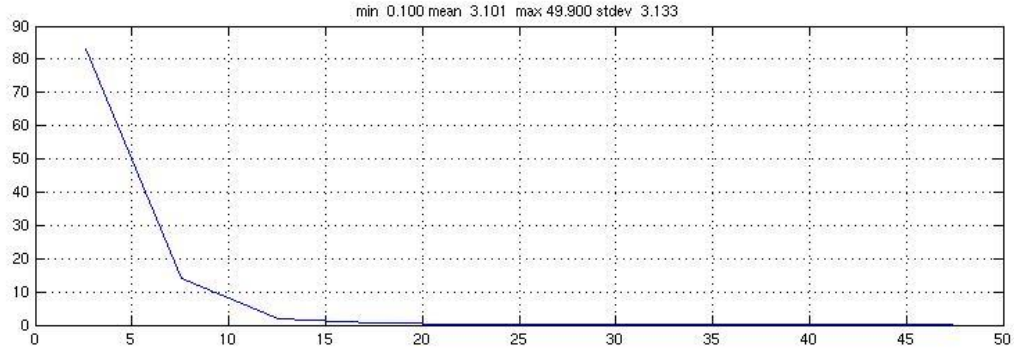
min 0.100 mean 3.101 max 49.900 stdev 3.133
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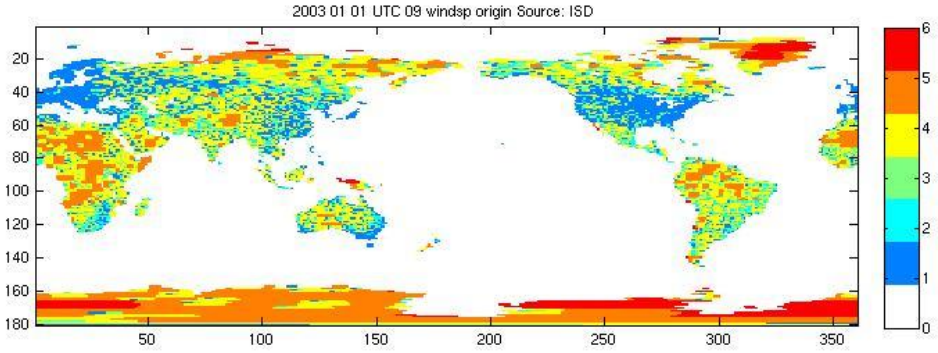
2003 01 01 UTC 09 windsp origin Source: ISD
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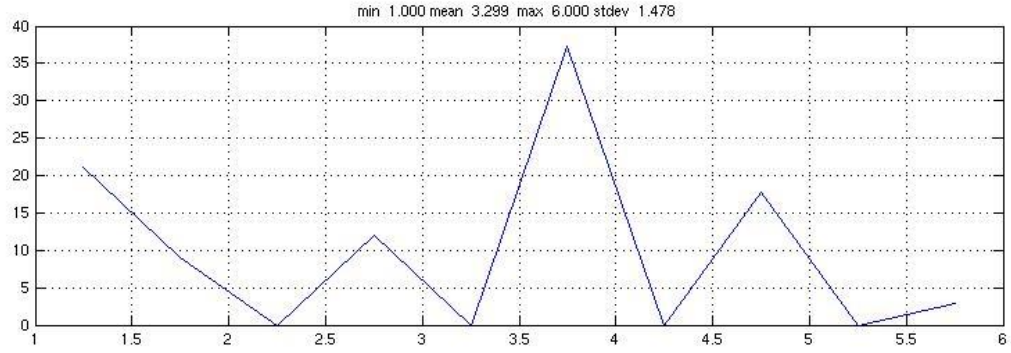
min 1.000 mean 3.299 max 6.000 stdev 1.478
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3.5
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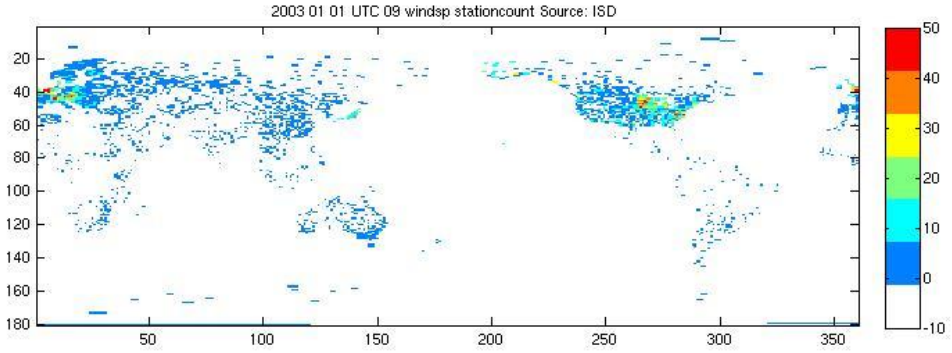
5.5
6


2003 01 01 UTC 09 windsp stationcount Source: ISD
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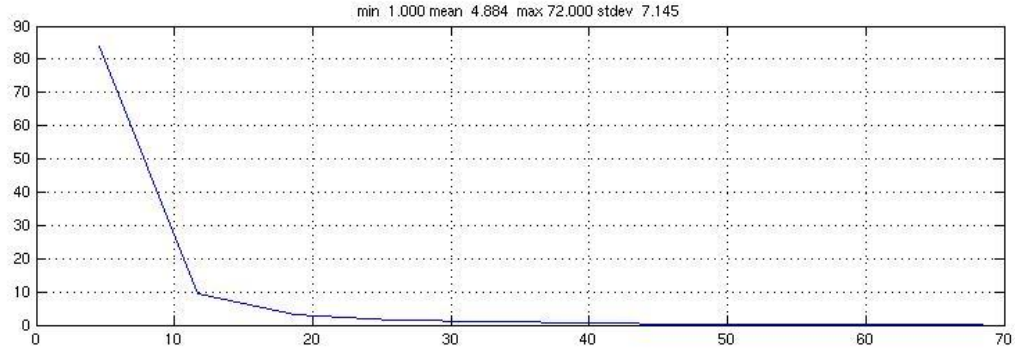
min 1.000 mean 4.884 max 72.000 stdev 7.145
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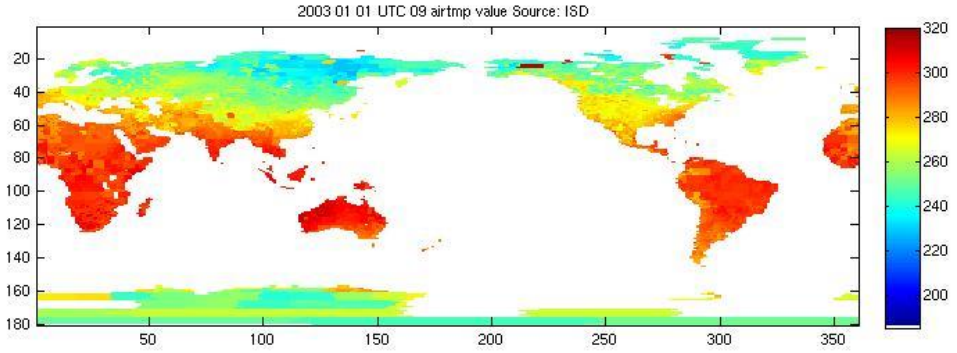
2003 01 01 UTC 09 airtmp value Source: ISD
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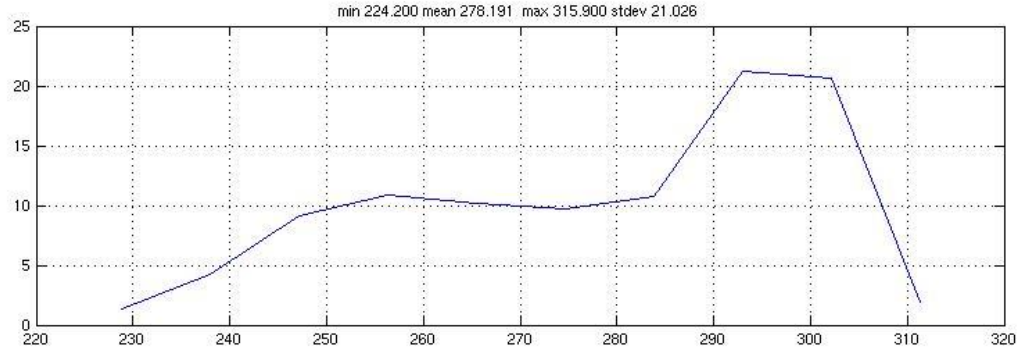
min 224.200 mean 278.191 max 315.900 stdev 21.026
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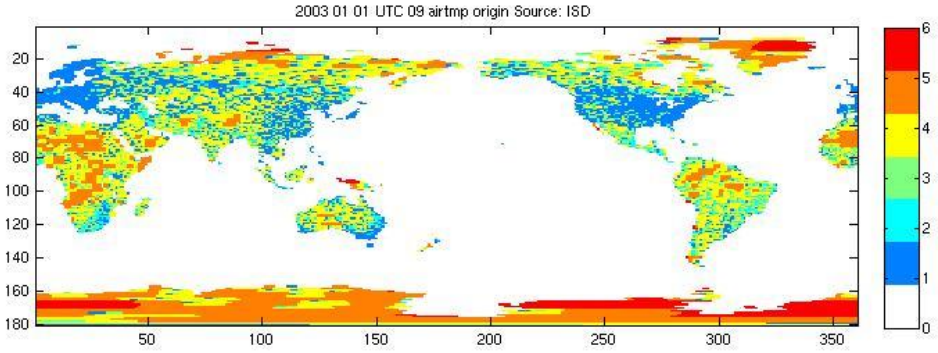
2003 01 01 UTC 09 airtmp origin Source: ISD
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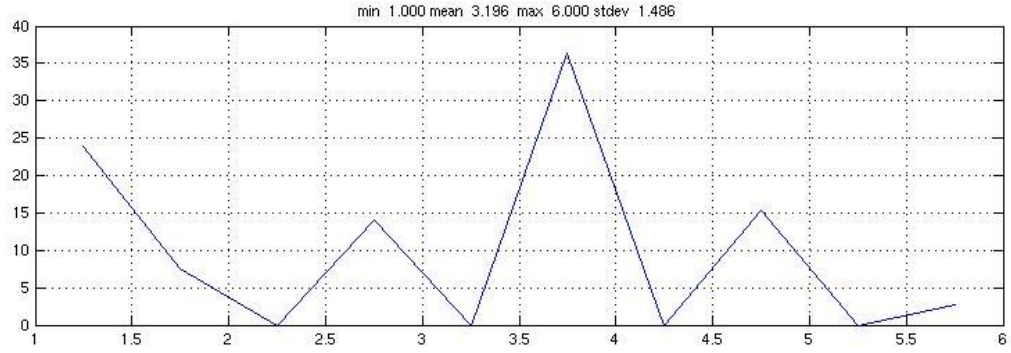
min 1.000 mean 3.196 max 6.000 stdev 1.486
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3.5
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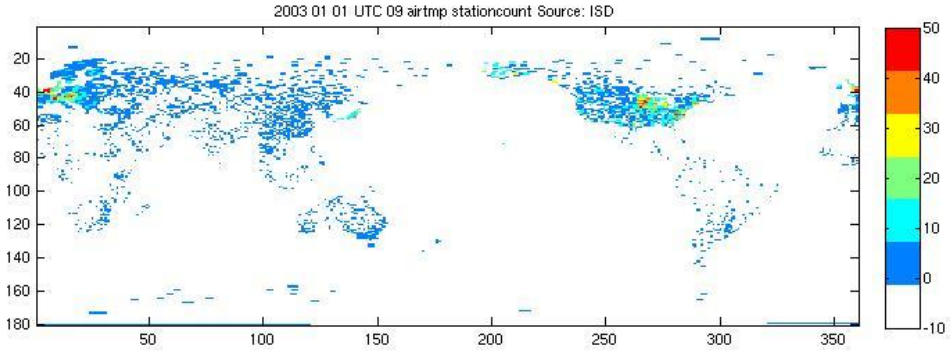
5.5
6


2003 01 01 UTC 09 airtmp stationcount Source: ISD
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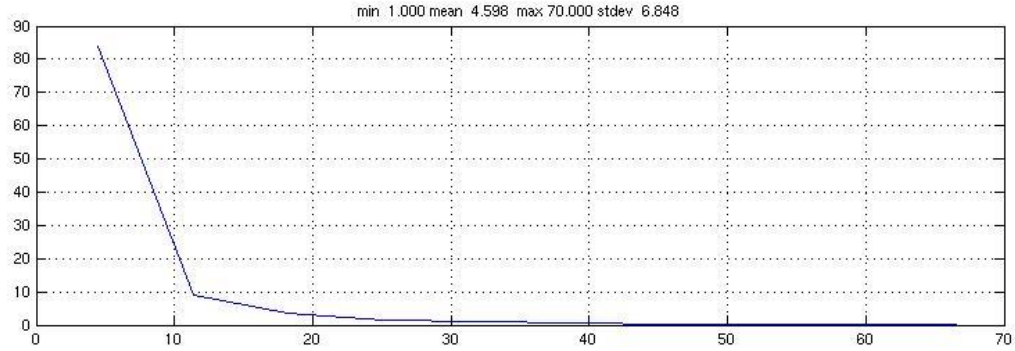
min 1.000 mean 4.598 max 70.000 stdev 6.848
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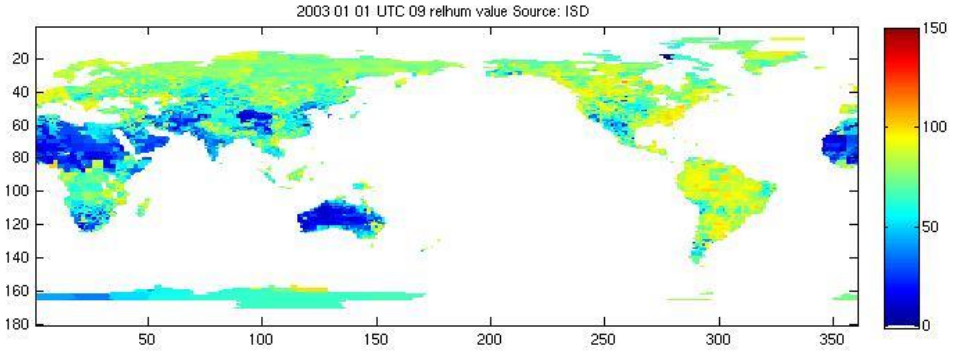
2003 01 01 UTC 09 relhum value Source: ISD
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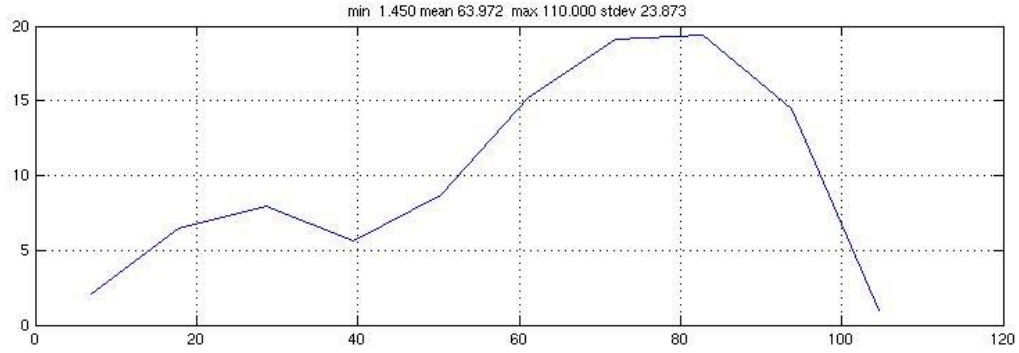
min 1.450 mean 63.972 max 110.000 stdev 23.873
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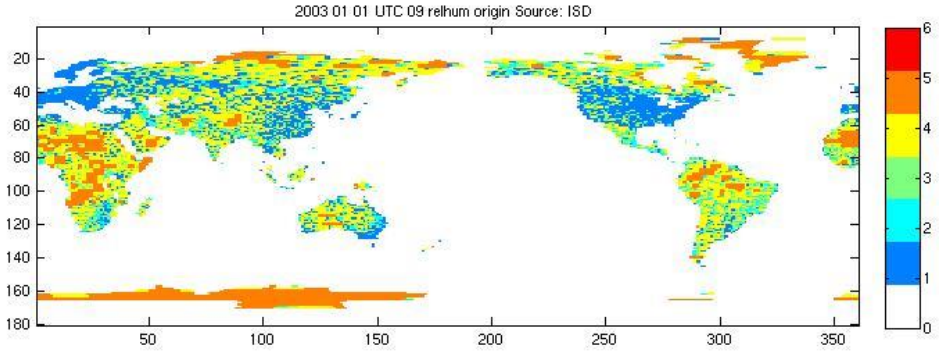
100
120


2003 01 01 UTC 09 relhum origin Source: ISD
20
40
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100
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160
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100
150
200
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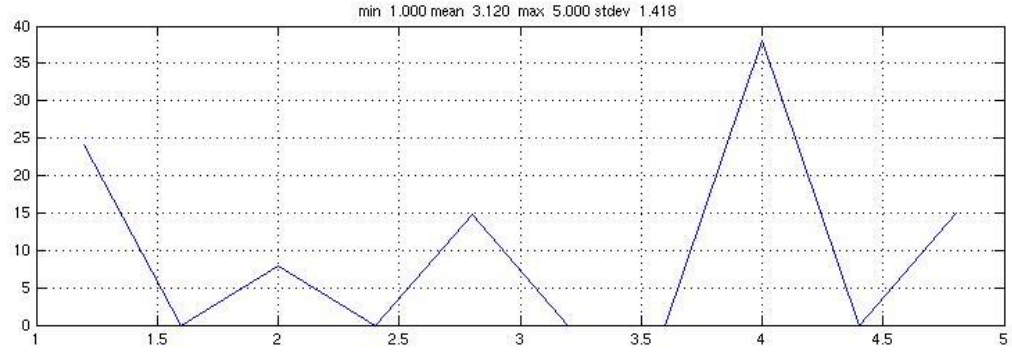
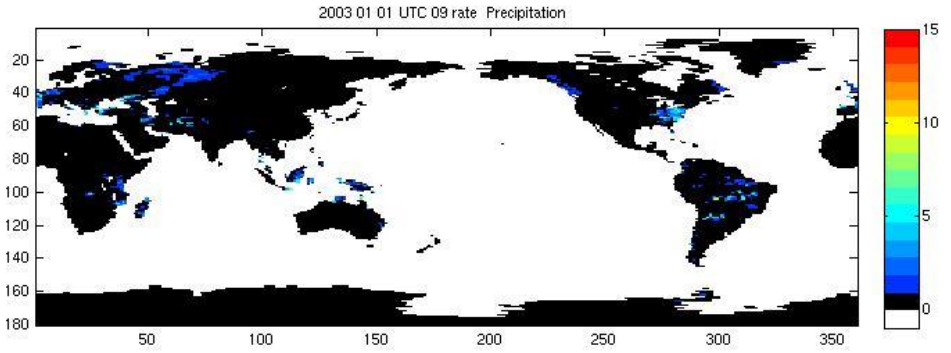
300
350
6
5
4
3
2
1
0


min 1.000 mean 3.120 max 5.000 stdev 1.418
40
35
30
25
20
15
10
5
0
1
1.5
2
2.5
3
3.5
4
4.5
5


2003 01 01 UTC 09 rate Precipitation
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100
120
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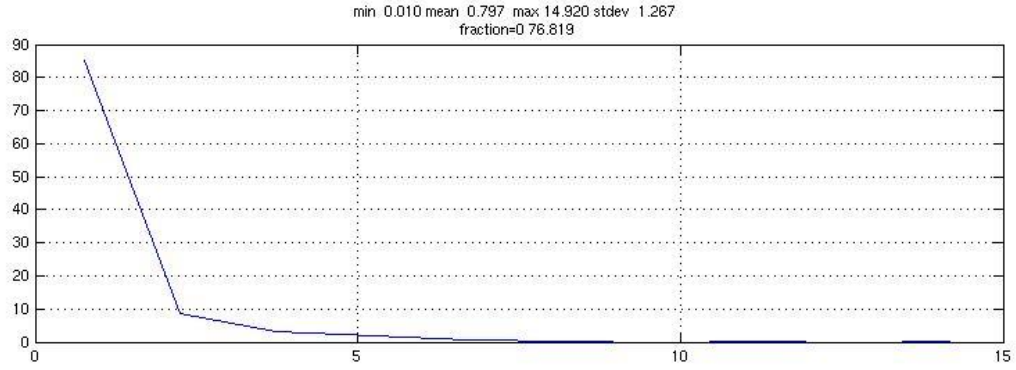
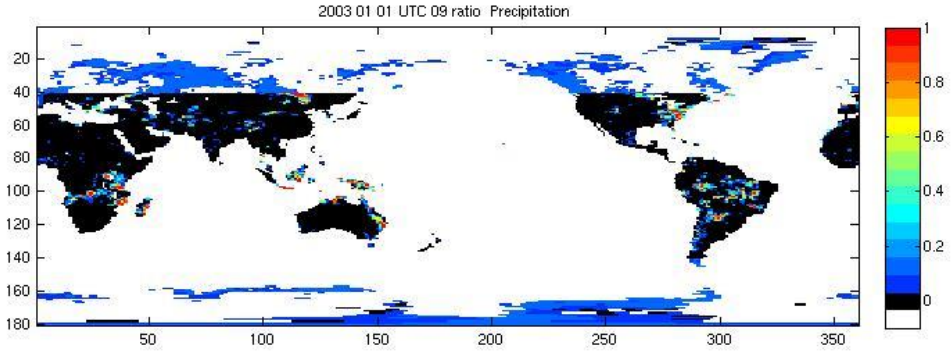
160
180
50
100
150
200
250
300
350
15
10
5
0


min 0.010 mean 0.797 max 14.920 stdev 1.267
fraction=0 76.819
90
80
70
60
50
40
30
20
10
0
0
5
10
15


2003 01 01 UTC 09 ratio Precipitation
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40
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80
100
120
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180
50
100
150
200
250
300
350
1
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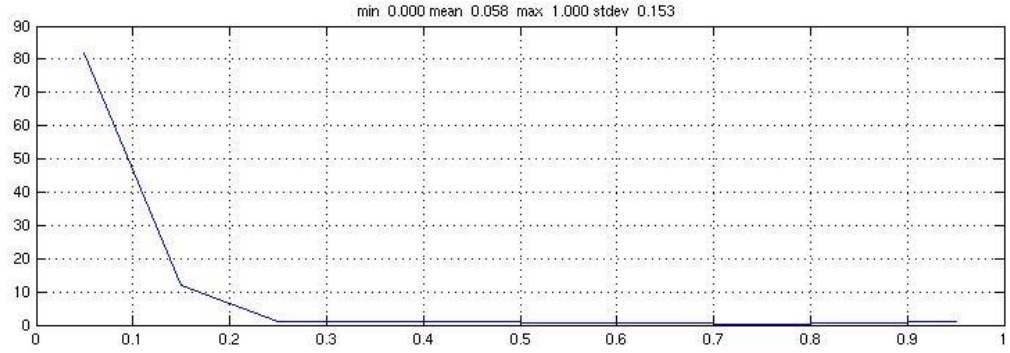
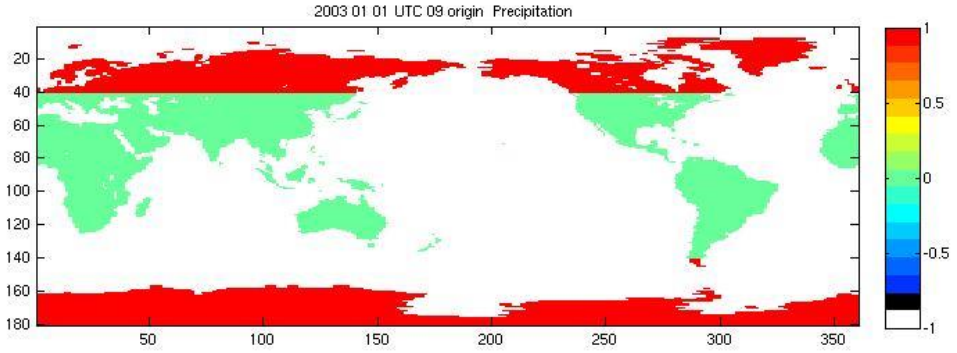
0.6
0.4
0.2
0


min 0.000 mean 0.058 max 1.000 stdev 0.153
90
80
70
60
50
40
30
20
10
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


2003 01 01 UTC 09 origin Precipitation
20
40
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100
120
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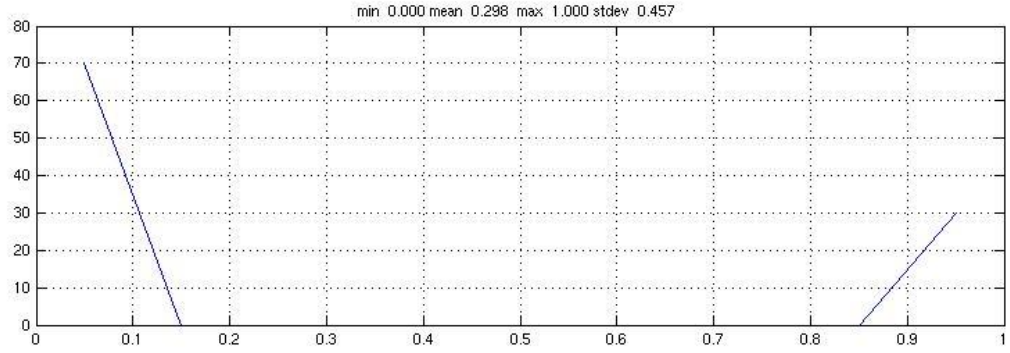
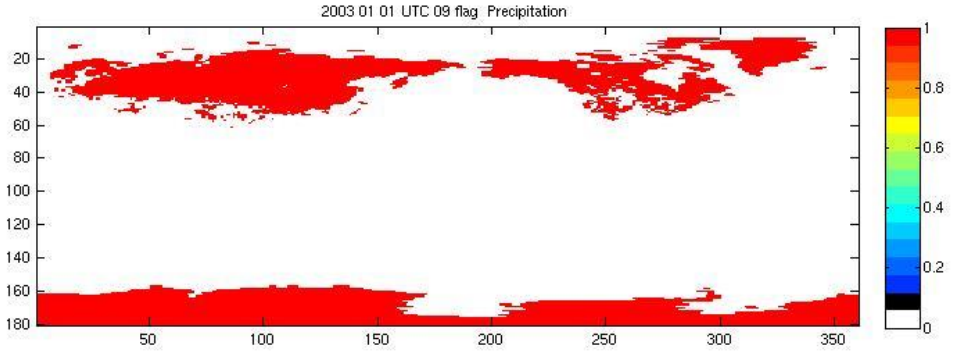
160
180
50
100
150
200
250
300
350
1
0.5
0
-0.5
-1


min 0.000 mean 0.298 max 1.000 stdev 0.457
80
70
60
50
40
30
20
10
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


2003 01 01 UTC 09 flag Precipitation
20
40
60
80
100
120
140
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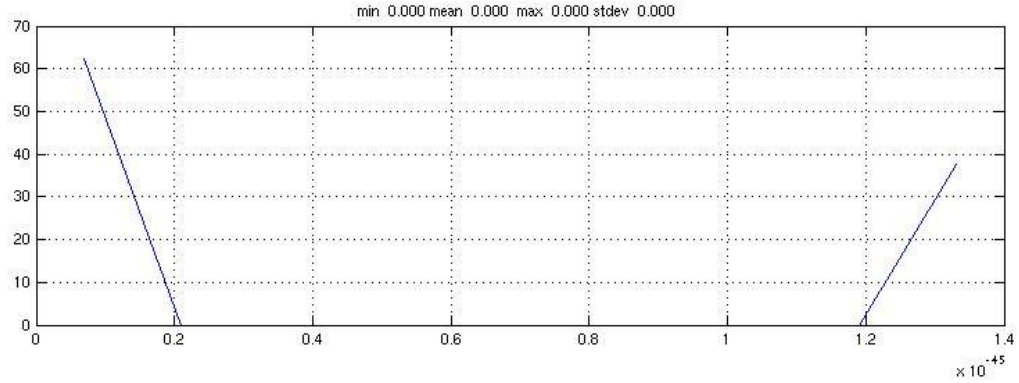
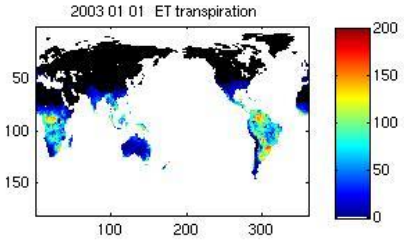
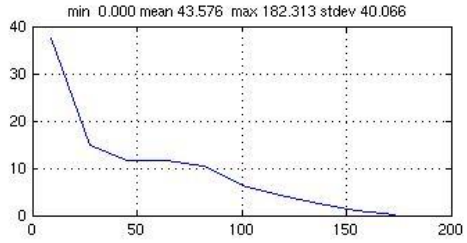
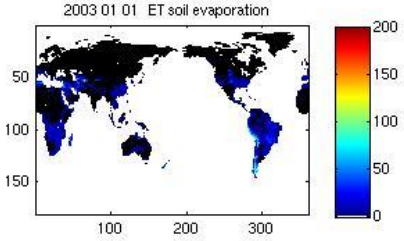
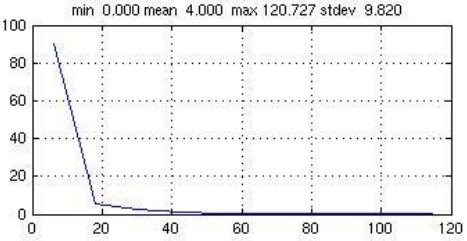
180
50
100
150
200
250
300
350
1
0.8
0.6
0.4
0.2
0

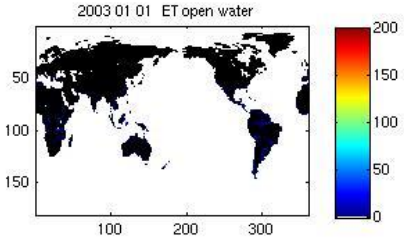

min 0.000 mean 0.000 max 0.000 stdev 0.000
70
60
50
40
30
20
10
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
x 10^-45

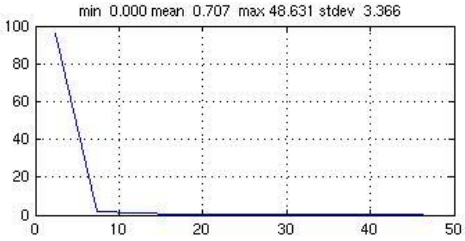

2003 01 01 ET transpiration
50
100
150
100
200
300
200
150
100
50
0

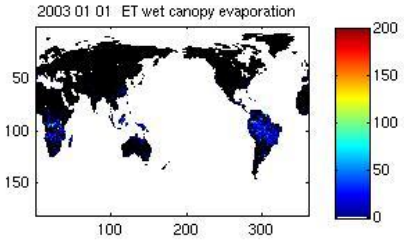

min 0.000 mean 43.576 max 182.313 stdev 40.066
40
30
20
10
0
0
50
100
150
200

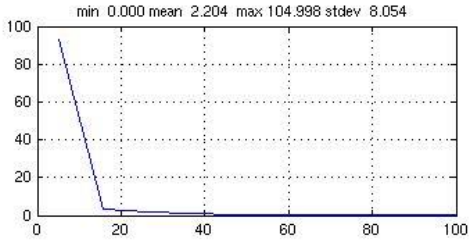

2003 01 01 ET soil evaporation
50
100
150
100
200
300
200
150
100
50
0

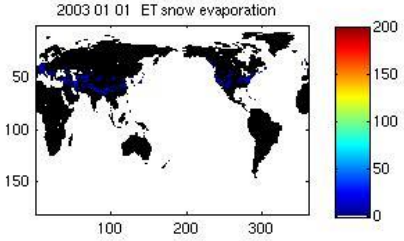

min 0.000 mean 4.000 max 120.727 stdev 9.820
100
80
60
40
20
0
0
20
40
60
80
100
120

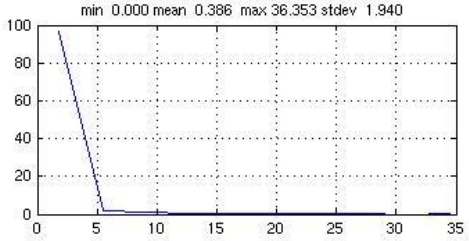

2003 01 01 ET open water
50
100
150
100
200
300
200
150
100
50
0

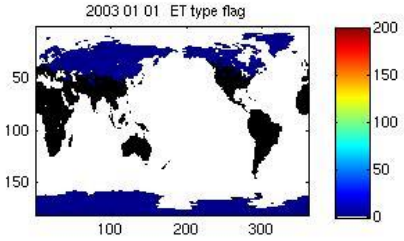

min 0.000 mean 0.707 max 48.631 stdev 3.366
100
80
60
40
20
0
0
10
20
30
40
50


2003 01 01 ET wet canopy evaporation
50
100
150
100
200
300
200
150
100
50
0


min 0.000 mean 2.204 max 104.998 stdev 8.054
100
80
60
40
20
0
0
20
40
60
80
100


2003 01 01 ET snow evaporation
50
100
150
100
200
300
200
150
100
50
0


min 0.000 mean 0.386 max 36.353 stdev 1.940
100
80
60
40
20
0
0
5
10
15
20
25
30
35


2003 01 01 ET type flag
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100
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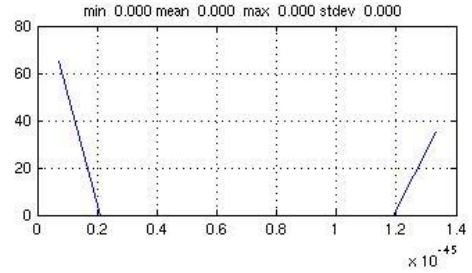
100
50
0


min 0.000 mean 0.000 max 0.000 stdev 0.000
80
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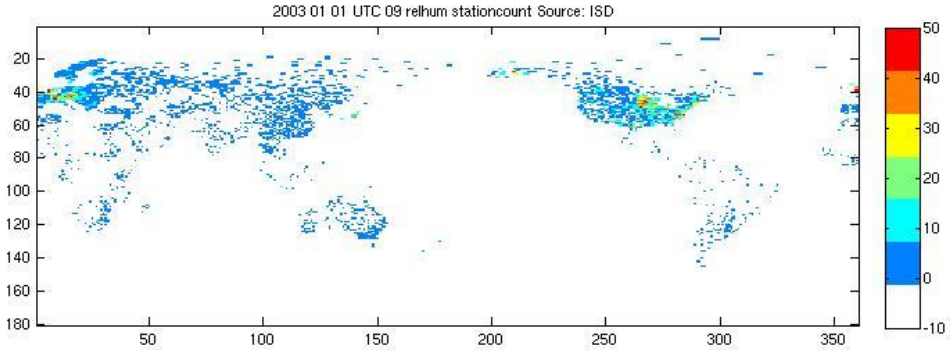
20
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
x 10^-45


2003 01 01 UTC 09 relhum stationcount Source: ISD
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160
180
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150
200
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350
50
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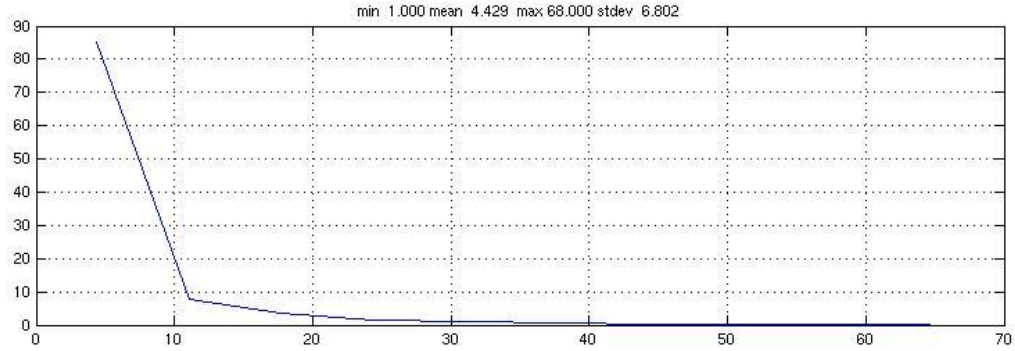
30
20
10
0
-10


min 1.000 mean 4.429 max 68.000 stdev 6.802
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80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70